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COST-EFFECTIVE AIR TRANSPORTATION
OF AUSTRALIAN DEFENCE FORCE
PERSONNEL WITHIN AUSTRALIA

THESIS

Anthony J. Green
Squadron Leader, RAAF

AFIT/GLM/LSM/88S-26

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DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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COST-EFFECTIVE AIR TRANSPORTATION OF AUSTRALIAN DEFENCE FORCE PERSONNEL WITHIN AUSTRALIA

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

Anthony J. Green, BBUS

Squadron Leader, RAAF

September 1988

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In performing this study I have received a great deal of help from others. I wish to thank the Staff of MOVCORDC for providing me the necessary movements data. I also wish to thank Squadron Leader Andrew Ware for spending his time gathering various pieces of data and information on my behalf. I am indebted to my advisor, Major Kent Gourdin, for the advice and encouragement throughout the time taken to complete the study. Thanks are also passed to Captain Carl Davis who chose to read and advise on the written content of the study.

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Anthony (Tony) J. Green

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GLOSSARY OF TERMS

Term	Definition of Term
ADF	Australian Defence Force
ADL	Adelaide, South Australia
AFO	Air Force Office
AMB	RAAF Amberley (Brisbane)
AMO	Air Movements Officer
ASIF	Airlift Services Industrial Fund
AUSMIMPS	Australian Standard Material Issue and Movement Priority System
BNE	Brisbane, Queensland
DAR	RAAF Darwin (Darwin)
EDN	RAAF Edinburgh (Adelaide)
FBN	RAAF Fairbairn (Canberra)
HQSC	Headquarters Support Command (Melbourne)
LAV	RAAF Laverton (Melbourne)
MAC	Military Airlift Command
MOVCORDC	Movement Coordination Centre
PEA	RAAF Pearce (Perth)
PTH	Perth, Western Australia
RAAF	Royal Australian Air Force
RIC	RAAF Richmond (Sydney)
SYD	Sydney, New South Wales

Term	Definition of Term
TVL	RAAF Townsville (Townsville)
TLM	Tullamarine Airport, Melbourne, Victoria
WLM	RAAF Williamtown (Newcastle)

Abstract

The purpose of this ~~research study~~ thesis was to determine the cost-effectiveness of current ~~RAAF~~ Royal Australian Air Force policy for the movement of personnel on temporary duty (TDY). TDY travel within the RAAF is undertaken through the use of RAAF scheduled air services. This mode of travel is considered a 'no-cost' means of moving personnel. Personnel travelling on TDY seldom travel by other modes of transport such as road, rail, or commercial air. Present RAAF policy requires that travel be by the most economical means, but by service air if practicable. This study uses three research hypotheses to test the cost-effectiveness of this current policy when compared to a policy where everyone travels by commercial air when going TDY. Two costs are used to make this comparison; the opportunity cost of productive time lost when travelling, and the cost of providing the air service.

The methodology used to make the comparison consisted of a simulation model to estimate the opportunity cost of each policy over 72 primary travel routes, and the total cost of each policy for the same routes. The calculation of the cost of providing the military air services was made using the methodology the USAF apply to calculation of ASIF cargo and passenger rates. [illegible]

The findings of the study show that the current RAAF policy for the movement of personnel on TDY is not cost-

effective. The primary factor contributing to this outcome is the opportunity cost of productive time lost. The cost of providing the military air services are substantially less than equivalent commercial fares. Within the military, the cost of personnel and administration are necessary costs. In order to sustain the Australian Defence Force's combat capabilities, personnel and administrative costs are not included in the cost of providing the military air services.

Recommended action to enable the movement of RAAF personnel on TDY to be cost-efffective is to allow personnel to incur a loss of no more than one working day before consideration is given to travelling by other means. If adopted, this recommendation would result in an RAAF policy as cost-effective as travel by commercial air only.

COST-EFFECTIVE AIR TRANSPORTATION OF AUSTRALIAN DEFENCE FORCE PERSONNEL WITHIN AUSTRALIA

I. Introduction

Movement, in the Royal Australian Air Force, is defined as the process of collecting, transporting, and delivering personnel, mail, and equipment. Movement can be effected by road, rail, sea, or air. Cost-effective use of transport systems and vehicles can be achieved through the logical application of principles and procedures of management. The fundamental and continuous objectives of movement/transport are to control and minimise the time-distance of lines of communication by the most suitable means (7:1-1). It is with this aim that the Royal Australian Air Force (RAAF) has been tasked with the responsibility for the provision and operation of RAAF transport aircraft to meet the needs of the Australian Defence Force (ADF). In certain circumstances RAAF transport aircraft may be used to move cargo and passengers for Commonwealth or State Governments or other organisations. RAAF transport aircraft may be used to meet these air movement commitments by the use of scheduled air services, special flights, and air transport support operations.

General Issue

Royal Australian Air Force policy for the movement of RAAF service personnel on temporary duty requires that the member travel by the most economical means, but by service air if practical. The origin of the requirement to travel by service air means is unknown, but appears to have been made on the basis that travel by service air is at no cost to the RAAF. The use of RAAF scheduled air services for the transportation of duty personnel appears to be uneconomical in terms of both time and money. A recent study which compared RAAF travel costs with civilian air charges revealed potential deficiencies in the system as it currently exists. Most of the problems arose from the lack of recognition given to the costs associated with moving personnel by C130 Hercules aircraft, and the effects of delays experienced as a result of travelling by scheduled services. The study concluded that the transportation of service personnel on temporary duty, by scheduled air services, had benefits but the deficiencies of the system were far greater than these benefits. The deficiencies found were primarily regarding the recognition of costs incurred by such travel, and therefore the overall cost-effectiveness of the system was jeopardised (2:78).

Airlift is the by-product of the requirement for an air force to train and prepare aircrews for possible conflict. Therefore the methods used by other air forces to cost and allocate the airlift by-product may provide a better way of

evaluating the use made of this by-product by the RAAF. Allied countries such as New Zealand, Great Britain and United States all operate C130 Hercules aircraft and are therefore able to provide an airlift service as a result of training requirements.

Specific Problem

The problem for this research effort is to determine if the existing RAAF policy for the movement of service personnel by commercial aircraft is cost-effective. If not, can a more realistic policy, that will take into account all peacetime travel related costs, be developed ? As a necessary step in researching this specific problem, methods of pricing RAAF scheduled air services will also be researched.

Scope of Study

Presently the RAAF scheduled air services utilise three types of transport aircraft: Lockheed C130 Hercules aircraft (both E and H models), Boeing B707 aircraft, and C7A Caribou aircraft. This study will be limited to the use of Lockheed C130 Hercules aircraft on scheduled air service routes within continental Australia. The reasons for this limitation are;

1. The Boeing B707 aircraft are soon to be refitted for the air-to-air refueling role and their utilisation in the transportation role is presently unknown;

2. The volume of passenger traffic transported on the C7A Caribou aircraft is less than ten persons per month and is therefore considered insignificant; and,

3. C130 Hercules scheduled air service flights to RAAF Butterworth, Malaysia, are primarily cargo flights while the passengers travel on B707 Butterworth Passenger Specials.

Background

The primary purpose of the scheduled air services is to convey Department of Defence personnel and cargo between key geographical locations and military establishments within Australia and nearby Malaysia. The majority of scheduled services utilise C130 Hercules aircraft, which are permanently based at RAAF Richmond and flown by No.'s 36 and 37 Squadron. In addition to the C130 Hercules, two scheduled service routes are flown by C7A Caribou aircraft and one route is duplicated (once per week) by a Boeing B707 aircraft when one is available; otherwise a C130 Hercules will fly the route twice per week.

RAAF Policy

RAAF personnel travelling on official business must travel in accordance with their movement authority. Travel requirements may be generated by any number of reasons including the posting of personnel from one base to another, the temporary posting (attachment) of personnel to attend courses, and the need for personnel to attend conferences or conduct staff visits. The travel authority for postings and

attachments is issued from Air Force Office in Canberra and includes an annotation which details how the member is to travel. The most frequent annotation is "Code 54" , which requires travel to be by the most economical means, Service air if practicable (5:A4). The origin and reason for the comment regarding use of service air if practicable cannot be found, but it reflects the general belief that the cost of travelling by service aircraft is free. The result of adding such a comment to the instruction is that unless exceptional circumstances exist, the member will go by service air no matter what the reason for travel. Defence Instructions do not provide a definite guideline for the use of scheduled air services, and this has led to their use based upon historical precedence.

When travelling to conferences the member does not require Air Force Office (AFO) approval and the decision on means of transport is left to base management. Travel by other than service air is also the exception in these cases (6:3).

RAAF Scheduled Air Transport Services

Since 1977, the RAAF has operated a schedule of air transport services similar to that which is operated today. Minor additions and deletions to the schedule have been made but the basic schedule has remained unchanged. The schedule is divided into both domestic flights (which includes RAAF Butterworth, Malaysia) and international flights. The

coordination of all the flights is managed by the RAAFs' Movement Coordination Centre (MOVCORDC), located at RAAF Richmond. Figure 1 shows the routes flown by the domestic schedule and Tables I to IV detail the routes and the frequency of the individual services shown on Figure 1. The domestic air services operate into each of the major mainland RAAF bases at least once per week while RAAF Butterworth is serviced every two weeks. Location acronyms used in Tables I to IV and Figure 1 are explained in the Glossary of Terms.

Table I

Southern Service (SS) Timetable

Frequency: Monday and Friday
Flight Route: RIC-FBN-LAV-FBN-RIC
Configuration: 2 pallets/66 passengers

Location	Arrive	Depart
RIC		0700
FBN	0800	0830
LAV	1000	1600
FBN	1730	1800
RIC	1900	

Note: On Wednesdays the SS operates LAV-EDN-LAV during the hours of 1100 till 1515.

Source: MOVCORDC

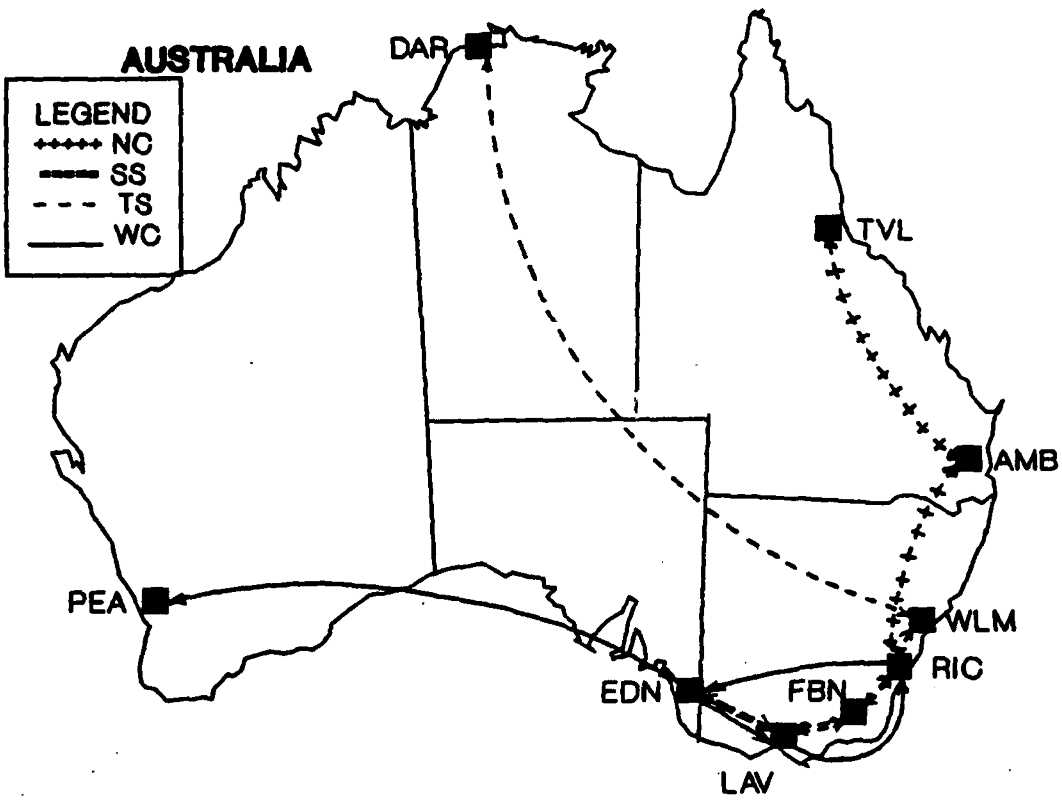


Figure 1. RAAF Scheduled Domestic Air Services

Table II

Northern Courier (NC) Timetable

Frequency: Tuesday and Thursday
Route: RIC-AMB-TVL-AMB-RIC
Configuration: 3 pallets/41 passengers (north)
2 pallets/51 passengers (south)

Location	Arrive	Depart
RIC		0840
AMB	1030	1130
TVL	1410	1510
AMB	1750	1850
RIC	2030	

Source: MOVCORDC

Table III

Western Courier (WC) Timetable

Frequency: Monday / Tuesday
Route: RIC-EDN-PEA (overnight) -EDN-LAV-RIC
Configuration: 3 pallets/41 passengers (west)
2 pallets/51 passengers (east)

Location	Arrive	Depart
RIC		1020
EDN	1250	1350
PEA	1720 *	0800
EDN	1330	1430
LAV	1650	1750
RIC	1945	

Note: * Aircraft remains overnight.

Source: MOVCORDC

Table IV

Territory Service (TS) Timetable

Frequency: Monday / Tuesday
Route: RIC-WLM-DAR (overnight) -WLM-RIC
Configuration: 3 pallets/41 passengers

Location	Arrive	Depart
RIC		0900
WLM	0950	1100
DAR	1710 *	0900
WLM	1545	1645
RIC	1730	

Note: * Aircraft remains overnight.

Source: MOVCORDC

Schedule Service Flying Hours

The flying hours necessary to operate the scheduled air services are allocated annually from the RAAF Flying Hour Program. The hours are allocated based upon bids from MOVCORDC, and the cost of these hours is automatically included in the overall support costs for the aircraft type. Over the past three years, the flying hours allocated to the scheduled air service operations have remained reasonably constant. Table V shows the hours allocated and the breakdown by aircraft type for scheduled air services in financial years 1985 to 1988. The reduction of hours for C130 Hercules scheduled air services in Financial Year (FY) 1987/88 was compensated with an increase in the B707 and C7A scheduled air service flying hours.

Table V

Flying Hours Allocated to C130 Hercules
Schedule Air Services 1985 - 1988

YEAR	HOURS
FY 85-86	2486
FY 86-87	2469
FY 87-88	1890

Source: MOVCORDC

Scheduled Service Aircraft Configurations

The C130 Hercules aircraft is a medium range transport aircraft designed for a multitude of activities. However, the aircraft is used solely for the carriage of duty personnel (opportunity space available passengers are granted travel when seats are available) and cargo when flying on a scheduled service task. The aircraft can be configured in many combinations for this role. Tables I to IV also detail the planning configurations used by MOVCORDC when managing passenger and cargo booking requests from the many ADF units. Planning configurations are based upon the number of people requesting duty travel in past years on the respective flights. This method of configuration planning has been in use for the past five years.

Utilisation of Scheduled Services

Passengers. Duty passengers must be booked to specific scheduled air services by MOVCORDC (6:3). Duty passengers are allocated a priority for movement under the Joint Priorities for the Movement of Passengers by Service Aircraft System (7:18-4). Duty personnel travelling on temporary duty for any of the reasons previously described are allocated a priority equivalent to Australian Standard Material Issue and Movement Priority System (AUSMIMPS) priority two. As such, a duty passenger can be removed from a scheduled air service to allow carriage of priority one cargo. However, this situation rarely occurs.

In accordance with the Joint Priorities for the Movement of Passengers on Service Aircraft, the priority two passenger must be transported on an aircraft within three days prior to the time required in a given location. This requirement stands for both the forward and return journeys (5:A-5).

Cargo. Cargo carried by scheduled air services is designated either priority one or two under AUSMIMPS. Appendix A shows the Joint Priorities for the Movement of Passengers and Cargo on Service Aircraft. Cargo which is required insitu by a given date, and is of either priority one or two, may be booked to a scheduled service by MOVCORDC. Any cargo that requires transport by air only must be booked also (6:2).

The selection of cargo, other than booked cargo, and the utilisation of the remaining capacity of the aircraft is left

to the discretion of the Air Movements Officer (AMO) at each of the bases. The AMO may choose between lower priority cargo and/or opportunity space available passengers.

Cost of Travel

No travel costs are incurred by individual units for the air transport service provided by a service aircraft, and meals enroute are provided at no charge to duty passengers (6:4). However, should a member travel by commercial means, then the unit is required to pay for the fares from the funds allocated to their Travel and Accommodation Appropriation (Funding Vote 234-06). This appropriation covers such things as travel costs (fares), travelling allowances paid to the individual member, meal allowances and other lesser costs for which the member may be reimbursed. The amount of funds allocated to this appropriation in financial year 1987-88 is A$34.918 million (22).

Research Hypotheses

To achieve the research objective of determining if the existing RAAF policy for the movement of personnel is cost-effective the following hypotheses will be tested:

1. Hypothesis I. The cost of moving RAAF personnel on temporary duty, in accordance with current RAAF personnel movement policy, is not cost-effective in terms of productive time lost waiting for and travelling on scheduled air services.

2. Hypothesis II. When the provision of RAAF scheduled air services is costed, current RAAF policy for the movement of personnel is not cost-effective when compared to equivalent commercial flights.

3. Hypothesis III. The cost of moving RAAF personnel on temporary duty, in accordance with current RAAF personnel movement policy, is cost-effective.

The combination of results from Hypotheses I and II will provide an overall result and thus a conclusion for the major hypothesis - Hypothesis III. The methodology to be used to test these hypotheses will be discussed in Chapter 3 of this study.

Outline of Research Study

This research study is presented in five major sections. Chapter I outlines the reason for the study and provides the reader with background to the RAAF personnel movements system. Chapter II asks several investigative questions regarding the study and then answers these questions in the form of a literature review. The methods used to test the three hypotheses are described in Chapter III, along with the sources of the data which was used in the study. The data and results of the methodologies are analysed in Chapter IV.

Finally, Chapter V discusses the conclusions and recommendations that have been made as a result of this study. Appendices are provided for support and to give additional details.

Nomenclature

The terms, abbreviations, and acronyms used commonly throughout this study are listed in the Glossary of Terms, which is found on page vii.

Assumptions

For the purpose of this study, productive work time is assumed to be between the hours of 0830 and 1630, Monday to Friday. Any travel undertaken outside of these hours is not considered as a loss of productive time, but relates to a morale issue rather than a cost issue.

II. Literature Review

Chapter Overview

The purpose of this Chapter is to provide the reader with an overview of the general issues involved in this study, and an awareness of the problem being researched. The Chapter examines published literature and government publications that address the general issue of transportation, cost-effectiveness, and methods used to cost transportation services. Following on from the Introduction and Background provided in Chapter I of this study, several general issues need to be discussed before a cost-effectiveness analysis can be conducted to answer the research questions. The general issues which will be discussed in this Chapter are;

1. What is cost-effectiveness ?

2. What are the current policies and procedures used by the United States Air Force for the movement of personnel on temporary duty ?

3. How does the Military Airlift Command (MAC) cost the airlift by-product for Channel Service flights ?

4. How are commercial air fares determined ?

5. What are the costs of travel ?

Following discussion of these general issues, previous studies relating to the RAAF scheduled air service policies will be discussed and some personal experiences retold. The findings of other studies and the experiences of RAAF

personnel add further evidence to the need for an in depth study of the cost-effectiveness of the RAAF scheduled air service system.

Cost-Effectiveness

William A. Niskanen describes cost-effectiveness as part of the general theory of maximising, positioned somewhere in the middle of the analytic spectrum between the classical theory of the firm at one end and the operations analysis at the other. Broadly defined it is any analytical study designed to assist a decision maker in identifying a preferred choice among possible alternatives. Each analysis should involve at one stage a comparison of alternatives in terms of their cost and their effectiveness in obtaining a specific objective. Usually the analysis consists of an attempt to minimise dollar cost subject to some mission requirement, or conversely to maximise some physical measure of output subject to a budgetary constraint (24:17).

Cost-effective analysis is specifically directed to problems in which the output cannot be evaluated in market prices, but where the inputs are substitutable at exchange relationships developed in the market (24:18). In areas such as defence planning, where there is no accepted theoretical foundation, advice obtained from experts working individually, or as a committee, depends largely on subjective judgment. So does the advice from cost-effective analysis, but the integrity of the analysis is that it is

able to make more systematic and effective use of judgment than any of its alternatives. In practically no case, should the cost-effective analyst expect to demonstrate to a decision maker, that beyond all reasonable doubt, a particular course of action is best (24:3).

To qualify as a complete cost-effective analysis, a study must look at the entire problem in its proper context. Characteristically such an analysis will involve systematic investigation of the decision maker's objectives, and, if relevant criteria is available, a comparison of the costs, effectiveness, risks, and timing associated with the alternate policies or strategies for achieving each objective (24:3).

United States Air Force Personnel Movement Policy

Air Force Regulation (AFR) 75-8 sets forth the policies and procedures for the worldwide movement of USAF sponsored personnel, whose movement is chargeable to Air Force appropriations. It is the goal of the Department of Defense (DoD) to use its own transportation resources to support defence missions, by the most responsive, efficient, and economic means possible. The DoD is responsible for having enough transportation resources on hand during peacetime to meet DoD emergency and wartime needs, taking into consideration the availability of commercial transport that can be used to supplement DoD requirements. The DoD

resources and operators are to be kept in a state of readiness to support the national defence mission (9:1-1).

Movement of personnel is to be by the least expensive mode of transportation that meets the needs of the mission. To find the least cost mode, consideration must be given to all costs by the Order Issuing Authority. Costs such as ground transportation, productive time 'lost' to travel, per diem, and actual fares. Primary use must be made of DoD owned transportation, or DoD commercial contract or charter services when possible. Commercial carriers may be used when it is considered necessary to meet mission requirements. Contract fares also exist between well travelled city pairs, and can be used only when they provide the lowest available fare authorised for official travel (9:1-1).

Travel orders are required for official travel. When a mission requires specific travel arrangements, the orders will 'direct the use of that mode'. This decision is left to the Order Issuing Authority, who is usually the Officer in charge of the member for whom travel is being arranged. If no specific mode of travel is stipulated on the order then the Traffic Management Officer (TMO) selects the mode of travel. In doing so the TMO is to consider the actual travel costs, mission requirements, lost work time, per diem allowances, subsistence, availability and reliability of service, and the comfort and desires of the traveller (9:3-1).

Local travel funds can be saved by wise use of operational support airlift. USAF Command policies allow flexibility and consider cost factors in addition to local travel funds. Military personnel must accept routing by military aircraft when local authorities say it meets mission needs as specified in the orders (9:1-1).

Industrial Funds

An industrial fund is a financial management system supported by commercial type accounting and is used as a means of financing work to provide goods and services which are in common demand. The industrial fund is self-sustaining, that is, it is reimbursed by customers for the costs incurred in producing the goods and services ordered. The opinion of some people is that an industrial fund provides managers with the best management tool, while others are of the opinion that management can best be accomplished by managing costs and funds by individual appropriation funds systems (1:24). The financing of operations with the industrial fund provides management with the opportunity to assess the economy and efficiency of operations, and permits the customer the ability to evaluate the selling price.

Key points to note regarding implementation of industrial funds are as follows:

1. the fund should be used to pay for all requirements of procurement and operation,

2. there are no free rides, and

3. all costs of services rendered must be paid for by the customer of the fund (1:25).

To be considered for approval as an industrial fund activity, the following criteria should be met:

1. The activity must be quantifiable and have a readily/easily measurable output.

2. The activity must provide stabilised rates or unit prices to the customers.

3. The activity must have a variety of customers.

4. The activity should provide a competitively priced product or service which may be obtained elsewhere (19:57).

The industrial fund is a 'no year' fund and is therefore not restricted to the fiscal period constraints as are appropriated funds. However, visibility and control of budgeting processes can still be maintained by the government. Visibility is maintained through the fact that an industrial fund is subject to audit and any financial acts of government. Control is present through the budget of the customer of the industrial fund. Customers of industrial funds, with few exceptions, are funded by appropriations (19:58).

Airlift Services Industrial Fund

The Military Airlift Command (MAC) does not exist to serve as an airline. However, the DoD does take advantage of the airlift capability MAC creates as it trains. If commercial rates are used, the DoD has the opportunity to save over a billion dollars annually by effectively using this airlift capability (12:22). The airlift by-product produced by MAC training is what differentiates MAC from other USAF Commands, and is also one of the reasons for the introduction of the Airlift Services Industrial Fund (ASIF). The ASIF is a management tool used to allocate the airlift by-product.

ASIF was implemented in 1958. Prior to this MAC covered all of its costs through its operations and maintenance appropriation funding. Therefore there was no cost to the user of the airlift service. There were procedures established to set airlift priorities and cargo eligibility, but there was no real penalty for exaggerating on what was a priority need. The implementation of the ASIF ensured stricter management of this premium airlift resource The fund establishes a buyer-seller relationship and the shipper is held responsible for transport mode selection (12:23).

Airlift capability is based on a wartime training requirement; MAC does not increase its flying activity to earn additional funds. MAC operates on a long term break-even basis; profits in one year reduce the tariffs in following years while losses increase later tariffs (12:23).

Tariff Computation. The calculation of ASIF tariffs is straightforward. The operating costs applicable to cargo movement are divided by ton miles of cargo movement requirements. The result is a rate per ton mile. There is also a per passenger mile rate computed and an hourly charter rate for each type of aircraft. All costs are based upon direct operating costs. The main point that needs to be understood is the entire operations of MAC are not financed through the ASIF. The cost base for tariff rates contains only those operating costs shown in Table VI. Rates are approved by the Office of the Secretary for Defense (OSD) approximately twelve months before the commencement of the fiscal year, and are not changed during the fiscal year (12:23).

Table VI

ASIF Cost Elements

ELEMENT	Percentage
Commercial Augmentation	28
Aircraft Operating Costs	
Aviation Fuel	34
Depot Maintenance	15
Civilian Pay	2
Supplies & Material	7
Travel/per diem	2
Facility Maintenance	5
Aerial Port Operations	5
Command and Control	2

Source: (4)

Initial Funding. When the ASIF was initiated, cash was provided through appropriation. This funding provided the operating capital for the ASIF. Currently ASIF has a $70 million corpus to operate its $2.5 billion annual operation (12:23). This approach to funding allows flexibility not found in annual appropriations. More importantly it puts a 'price tag' on the service which increases awareness of the economic value of the airlift service and provides a cost to the mission supported.

ASIF Improvements. There have been several changes to the ASIF intended to apply the airlift product more efficiently. One such action has been to tie the MAC tariffs more closely to the price of renting a commercial aircraft. With the tariff tied in some way to the cost of commercial augmentation and rate stabilisation, in effect the users and operators have a meaningful yardstick to measure the true economic value of air transportation (17:42).

In summary, the ASIF is a management tool used by MAC to promote the efficient use of airlift. Paying for airlift allows the user to compare alternate modes of transportation. MAC is restrained from being totally cost efficient by virtue of their primary mission of wartime readiness. However, the ASIF is not designed to be a cost recovery system, rather a commercial cost equivalent system (4:5).

Commercial Methods of Costing

A review of air transport literature provided very little insight into how commercial airlines cost passenger air fares. However, Cost Allocation Reviews conducted by the Independent Air Fares Committee (IAFC) provided some guidelines as to how air fares are determined for commercial passenger flights. Air fares were described as consisting of three components: a fixed initial amount often referred to as the 'flag-fall', an amount for each mile travelled called the 'distance' component, and an amount which is called residual costs. All of the costs which the airline incurs when providing a service are then broken into a percentage factor that goes into making up an airfare (13:6). For example, the fuel used in providing a flight is costed based upon 20% 'flag-fall' and 80% on distance. Other costs such as administration are costed 100% pro rata. Table VII provides the suggested methods of cost allocation for the two major Australian airlines; Ansett Airlines of Australia (AAA) and Australian Airlines (AA) (formerly Trans Australian Airlines (TAA)). Table VII is an extract and therefore does not show all costs included by commercial airlines.

Table VII

Suggested Methods of Cost Allocation
For TAA and AAA
(all figures are percentage)

COSTS	AAA			TAA		
	FF	D	R	FF	D	R
Fuel	20 :	80 :	0	20 :	80 :	0
Fuel Excise	20 :	80 :	0	20 :	80 :	0
Flight Crew	0 :	100 :	0	12 :	56 :	32
Engineering	46 :	54 :	0	29 :	17 :	54
Flight Attendants	0 :	100 :	0	33 :	44 :	23
Catering	70 :	30 :	0	0 :	85 :	15
Ground Serv.	100 :	0 :	0	69 :	7 :	24
Admin.	0 :	0 :	100	0 :	0 :	100
ADP	60 :	0 :	40	60 :	0 :	40
Treatment of Residual	Pro Rata			All on distance		

Note: Flagfall (FF) : Distance (D) : Residual (R)
Source: (13)

Costs Elements of Transportation

Two major general categories of airline cost accounts are direct and indirect costs. Eston T. White defines direct costs as those costs incurred in the actual day to day operations and maintenance of the aircraft. Indirect costs are those expenses required to sell and service the traffic, and the general administrative costs. Included in the latter group are the wages of flight attendants and the costs of food and beverages provided on passenger flights (25:93).

Direct Costs. In the military the costs involved are similar, but the operating costs may well be incurred simply by the need to train aircrew and therefore can be argued as a

non-cost when transporting service personnel on a service flight. Gary K. Belford identified many of the costs to be incurred when travelling on a service aircraft. Some of these costs were: accommodation costs (enroute stopovers), cost of time, meal and subsistence allowances, and the cost of freight foregone when a passenger is boarded in lieu (2:38). Under the ASIF, the MAC identifies the cost base for the tariff rates as containing only those operating costs listed in Table VI.

<u>Indirect Costs</u>. Two indirect costs incurred by the military when personnel travel on temporary duty are the cost of allowances paid to the member during his absence from his nominal workplace, and more significantly the cost of time lost to travel. Stubbs et al state that one of the most important areas in transport in which management try to establish a value that is not explicit or immediately apparent, is a value of time saved by travellers (20:107). Journeys made by an individual during normal working hours usually subtract from the time he is available to work. James P. Stucker in his study of transport improvements, commuting costs, and residential locations identified two components to travel costs: the direct money costs incurred by the traveller and the indirect opportunity cost of travel time. The value an individual places upon the time he spends travelling is subjective and based upon his preference toward travel, work, and his alternative uses of that time (21:22,23). Studies on air travellers have recorded a higher valuation of

travel time. The Institute for Defense Analyses has concluded, from a study on the demand for air travel by supersonic transport, that the passenger acts as though he values his time at approximately his earning rate. No evidence was found to suggest that those persons travelling for personnel reasons differ in this respect (14:16-19). However, Granau disputes this latter finding. Granau found that the value of time for business trips is probably equal to the wage rate, but for personnel trips, it may well be zero (11:51).

Other Studies

One other study is known to have investigated the current RAAF personnel movement policy. This study was conducted by Gary K. Belford in 1986 (2). Belford's research paper examined the movements of RAAF personnel on C130 Hercules aircraft and the costs associated with such travel. Belford collected passenger movements data for movements throughout the entire RAAF scheduled air service network and then chose five locations for further study purposes. The five locations chosen were: Richmond, Fairbairn, Laverton, Pearce, and Amberley. These five locations provided a range of movements displaying various characteristics such as variation in the number of scheduled movements through the location, and the geographical location in relation to the overall network of scheduled air services (2:21). Belford discovered that there was no trend in the number of passenger

movements during the period 1982 to 1985, but that distinct 'seasonal' fluctuations attributable to financial and vacational periods of the year were evident (2:27).

In order to develop a cost analysis methodology, to facilitate the comparison of the scheduled air service costs to those incurred if travel was by commercial means, Belford estimated the total costs incurred by the RAAF: the value of all the RAAF resources that were used to achieve the desired result. Belford identified costs into the categories of fixed and variable. Fixed costs, he concluded, were those costs to be incurred by the RAAF no matter how the aircraft was to be utilised. The variable costs were those costs associated with providing the airlift services. Costs included as variable costs were; personnel wages, accommodation, meal costs, and cost of cargo space utilised by duty personnel. The opportunity cost of time travelling was not included in Belford's total cost calculations for air fare comparison purposes. Additionally, a major assumption made by Belford in his study was that if the method of transportation is not service air, then the member does not travel at all (2:38,53,28). This assumption is very much incorrect and is not an AFO policy.

Three possible alternative methods for costing the carriage of duty personnel were evaluated by Belford. The first two methods were discarded as they made no consideration of the need to carry cargo of a higher priority

than passengers. The method chosen for costing a seat on a RAAF scheduled air service assumed that cargo was always available for carriage (2:47). The cost of a seat on a flight was calculated as the cost of lost cargo capacity due to passengers. Two problems exist with this costing approach:

1. The assumption that cargo would always be available is not a safe assumption, as aircraft flying as 'cargo specials' often fly similar routes to the scheduled air services with the task of carrying as much freight as possible, and

2. The costing of a seat on the flight was dependent upon the number of passengers actually travelling, this leads to variable rates and therefore management cannot make informed decisions about the best method of transportation (2:47).

Belford's study recommended amendment to RAAF personnel movement policy. Recommendation was that a supplement, which is both definitive and comprehensive, should be included with the present policy. The supplement should be designed to enable managers to overcome the confusion regarding what method of transport should be used. In addition Belford suggested that better recognition should be given to the costs involved in providing the scheduled air services with the aim of being able to reassess the movement system at any time (2:77).

Personal Experience

Over the past seven years I have personally experienced the good and bad aspects of RAAF personnel movement policy. These experiences have been gained through five years of employment as an AMO, and two years in an employment position having substantial travelling obligations throughout Australia. On one occasion, two airmen and I needed to travel to a Preliminary Planning Conference regarding an exercise in which our unit was to participate. The Conference was scheduled for two days, but in order for the three of us to attend we had to travel by service air. Subsequently we were absent from our nominal workplace on temporary duty for a period of six working days. Four of these days were spent waiting for and travelling on scheduled service aircraft. This is not an unusual occurrence.

Another example occurred when I had to travel to Melbourne for a meeting with a commercial contractor. A total of three days were lost travelling. The meeting was for two days, Tuesday and Wednesday, and was scheduled to allow members attending from distant locations time to travel. Some of the other military attendees spent a total of five working days travelling for this same meeting.

These are just two of my experiences. As AMO for five years, at Airmovements Section Richmond, the complaints regarding travel from many of the transient passengers were never ending. However, from experience the final decision on travel is sometimes determined by two other factors.

Firstly, a requirement for a member to remain at his nominal work place for extraordinary reasons, and secondly, the amount of funds remaining in the Unit's Travel and Subsistence Appropriation. Both can impact on the final decision regarding a members travel arrangements. In some cases the members superior can and will make necessary management decisions regarding the employees travel requirements.

Summary

This chapter discussed five general issues, in order to provide background for the methodology to be used in solving the research question. A recent study conducted by Gary K. Belford on the transportation of Australian service personnel by RAAF scheduled air services was also examined. Cost-effectiveness as it pertains to the defence environment was discussed and the current USAF policy for the movement of personnel was summarised. Methods of costing air fares was looked at from both the military and commercial aspects. The ASIF method of costing was discussed in detail and the suggested method of cost allocation for AAA and AA (formerly TAA) was summarised. In addition to the costs incurred by the carrier, the cost incurred by the traveller were also discussed. The opportunity cost of time spent travelling was identified as a cost which is seldom considered, nor valued appropriately. This cost has a significant impact on the

productive time of an employee if the travel period is during his normal working time. Finally, some personal experiences involving the RAAF personnel movement policy were cited as additional support.

III. Research Methodology

Chapter Overview

This chapter describes the research design which will be used to test the three hypotheses stated in Chapter I of this research study. The population of interest, the type and source of data to be used, and the specific methodology which will be used to test each of the three hypotheses will be discussed in detail. Reference will be made to the Airlift Services Industrial Fund costing structure outlined in Chapter II, and to those costs considered by Belford in his research study and also discussed in Chapter II of this study.

Population of Interest

The population of interest for this study is all Australian Defence Force personnel who use the RAAF scheduled air services as a means of transport when travelling on official defence force business. Samples for the study will be taken from data available from MOVCORDC and the RAAF Airmovements Sections. Due to the time available and the the lack of immediately accessible data sources, a sample of the overall system will be used for the purpose of this study.

Data Collection

Passenger Data. Passenger data has been provided by MOVCORDC. The data provided was in the form of Scheduled Service Passenger and Cargo Consolidation Lists, which provide details such as flight number, passenger details (name, rank, origin, and destination), cargo booked to the flight, and any other pertinent information necessary for the AMO to perform his work. This data was provided for all scheduled air services over the period May 1987 to October 1987. In addition to the Consolidation Lists, MOVCORDC also provided information on the number of Requests for Passenger Booking that had to be denied due to lack of available seats on specific flights. This data was collected over a period of three months, between August 1987 and October 1987. Total passenger movements data through the RAAF scheduled air service system, for financial years 1982 through 1987, were also obtained from MOVCORDC.

Official Business Data. Official business duration times were collected by means of telephone interviews with RAAF members in Australia. A total of 15 persons were interviewed and a total of 35 conference duration times were obtained. In addition to the duration of the 35 conferences mentioned, the commencement date, or the date the member was required to be in location, was also obtained for the same conferences. RAAF members interviewed were located at RIC, DAR, and AFO. The telephone interviews were of a structured nature, whereby the members called were asked the following questions;

1. How many conferences had they attended, in the last three months, that required travelling by service aircraft ?

2. What was the scheduled duration of these conferences ?

3. On what day of the week did each conference begin ?

4. Could they have travelled by another means of transport ?

5. How many days, if any, did they spend travelling and waiting for service aircraft ?

The selection of persons to be interviewed was done randomly from persons known at those locations. The rank structure for the interviews was based upon the overall rank distribution of those personnel who have travelled on scheduled service aircraft during the period May 1987 to October 1987.

C130 Hercules Cost Data

As mentioned in Chapter I, a major problem with the use of a scheduled air service is the lack of recognition given to the costs associated with providing the service. Cost data for this study has been provided by the Directorate of Supply Financial Programming - Air Force, Canberra, Australia. Presently the cost of providing the airlift is included in the maintenance and supply support financial appropriations. These appropriations are based upon the

Flying Hour Program and the cost of supporting the aircraft, for a known number of flying hours, in the previous financial year.

Commercial Airline Cost Data. Australian commercial airline data has been obtained from the brochures published by the two major airlines in Australia; Ansett Airlines of Australia, and Australian Airlines. Flight timetable publications were those effective up until 20 March 1988, and the flight fares are those effective from 23 July 1987. The air fare charges used in this study are the one-way economy fares between capital cities adjacent to the RAAF bases. The one-way economy air fare is the maximum charge that would be levied by the commercial airlines. As a result of the Australian Government's Two Airline Agreement, the air fares of the two intercity airlines are similar.

Flight Distance Data. Flight distances have been taken from Defence Instruction (Air Force) Australian Air Publication 1127, Airportability Criteria, Chapter 2, Annex A. This Annex shows the air distance between the RAAF bases serviced by the scheduled air services.

Research Method

Three research hypotheses have been made in order to solve the research question. The three hypotheses to be tested are:

Hypothesis I. The cost of moving RAAF personnel on temporary duty, in accordance with current RAAF personnel

movement policy, is not cost-effective in terms of productive time lost waiting for and travelling on scheduled air services.

Hypothesis II. When the provision of RAAF scheduled air services is costed, current RAAF policy for the movement of personnel is not cost-effective when compared to the cost of travel on equivalent commercial flights.

Hypothesis III. The cost of moving RAAF personnel on temporary duty, in accordance with current RAAF personnel movement policy, is cost-effective.

The remainder of this Chapter will detail the methodology used to test the three research hypotheses. The methodology for Hypotheses I and II will be outlined first as their results will be used in the evaluation of Hypothesis III.

Hypothesis I

The objective of this hypothesis was to evaluate the opportunity cost of delays experienced as a result of travelling by scheduled air services. One cost often overlooked is the opportunity cost associated with travel. The cost of work foregone, as a result of travel, is represented by the cost normally incurred to employ the member over the same period of time to do required work. It is assumed that the member would be productive during this same period and that work hours are used efficiently and effectively. Therefore, only working days lost due to travel have been included in this cost analysis.

Simulation Formulation. Due to the limited data availability and the lack of time and resources, a decision was made to evaluate Hypothesis I by using simulation. The essential concept of simulation is one of conducting experiments on a model of a system. A broad definition is "the technique of solving problems by observation of the performance, over time, of a dynamic model of the system" (10:39). A single run of a simulation model provides one point outcome from an array of possible outcomes, and the replication feature of simulation models can be used to draw out the properties and interrelationships in a way which provides insight for managers into the value of possible decision alternatives.

Validation of a model also presents some problems. There are many concepts of validity, but one most used in simulation literature treats validation as testing the agreement between the model and that of the real system (18:210). In the absence of the 'real' system against which to test a hypothetical model, the achievement of internal validity - confirmation that the model is behaving as intended - an informal and authoritive judgment that the model is a reasonable approximation of the likely reality would seem to be the most useful technique available for validation.

The purpose of the simulation was to estimate the opportunity cost of the time lost by RAAF personnel when travelling on a scheduled air service. This simulation was

also designed to test alternative RAAF personnel movement policy and its affect on the opportunity cost of travel by scheduled air services.

All combinations of TDY travel between the nine major RAAF bases were decided upon for the purpose of the simulation. This provided a total of 72 combinations over which the simulation could estimate the cost of current RAAF personnel movement policy costs. The simulation estimated the policy cost for both the forward and return journey between the two RAAF bases nominated.

The statistics gathered from the simulations included the average cost of productive time lost due to travelling, and the average total cost for the journey. The total cost figure included the commercial and estimated military airfares, and ground transfer charges when applicable. Results obtained from the simulations were compared to costs incurred under a policy where all TDY travel was via commercial air and conclusions were drawn from the hypothesis test results.

Hypothesis II

The comparison of the cost of RAAF airlift services to the equivalent commercial fare is the objective of this hypothesis. The first step in testing this hypothesis is to determine the cost of operating RAAF scheduled air services. This cost will be calculated by using the United States Air Force ASIF costing structure described in Chapter II. The

elements of the ASIF cost will be aligned with the C130 Hercules operating costs in order to give a total cost of operating the scheduled air services. Next the methodology used by MAC to determine a cost per mile for a seat on an ASIF Channel Service flight will be used to estimate a cost per mile per seat on a RAAF scheduled air service. From this the cost of a sector on a RAAF scheduled air service can be estimated and compared with the commercial air fare for similar flight sectors.

Hypothesis III

Evaluation of this hypothesis will be performed by combining the results of Hypotheses I and II. The average cost of a delay, given a particular scenario, and the estimated cost of travel on a scheduled air service can be added to give a total cost of travel. This total cost will then be compared to the commercial air fare and a conclusion can be made regarding the results of this comparison.

Summary

The overall objective of this study is to determine if the current RAAF personnel movement policy is cost effective. This will be achieved through the use of the ASIF costing methodology, to estimate a cost per mile per seat on a RAAF scheduled air service, and the use of a simulation model to estimate the average opportunity cost of time lost waiting for and travelling on RAAF scheduled air services. The

combination of these two costs will then be compared with equivalent commercial air fares. In addition the simulation will enable testing of alternate RAAF policy in order to find the optimum policy for minimising opportunity costs.

IV. Data Analysis and Evaluation

Overview

The purpose of this chapter is to present the analysis and findings of the research. Each of the three research hypotheses will be discussed separately. The data analysis procedures will be detailed first, followed by a description of the findings for each of the hypotheses being evaluated.

Hypothesis I

RAAF personnel movement policy requires personnel to lose up to three working days before consideration is given to travel by a more expeditious mode, usually commercial air. Given this policy, the first hypothesis tested was that the estimated opportunity cost of travel by military scheduled air services was higher than the opportunity cost of equivalent travel on commercial air services. Opportunity cost data used to test this hypothesis was generated by a SLAM II (Simulation Language for Alternative Modelling) simulation program specifically written for this study.

Analysis

Data used to estimate the opportunity cost of travel by military scheduled air services and commercial air services are as follows:

1. Passenger Data.
2. Official Business Data.
3. Salary Data.
4. Travel Transit Time Data.

Passenger Data. Passenger data used in the simulation refers to the rank structure of personnel travelling from each location. This information was obtained from RAAF Scheduled Service Passenger and Cargo Consolidation Lists. Data was collected for all nine major RAAF bases which are serviced by the scheduled air services, using the following five rank categories:

1. Corporal (i.e. E5) and below - Category 1.
2. Sergeant and Flight Sergeant (i.e. E6 and E8) - Category 2.
3. Warrant Officer to Flight Lieutenant (i.e. E9 to O2) - Category 3.
4. Squadron Leader (i.e. O3) - Category 4.
5. Wing Commander (i.e. O4) and above - Category 5.

These categorical breakdowns were chosen based upon the numbers obtained from the Consolidation Lists. For example, very few personnel of group captain rank or above were found to travel on RAAF scheduled air services, whereas corporals

and below made up significant numbers. A second reason for using these categories was that up to the rank of flight lieutenant many of the ranks overlap in their pay structure, and the data available from the Consolidation Lists does not indicate the time a person has in a given rank or an airmens mustering. The rank structure of passengers departing on TDY activities from each of the nine RAAF bases used in this study is shown in Table VIII. The figures were calculated from the Consolidation Lists provided by MOVCORDC.

Rank category distributions for each of the nine locations were compared using Tukey's method for multiple comparisons. Tukey's method utilises the Studentised range to determine whether the difference in any pair of sample means implies a difference in the corresponding treatment means (15:715). The treatments used in the test were the locations from which the samples were taken, i.e. Darwin, Townsville, etc. The results of this test are at Appendix B. Results show that at a 95 per cent level of confidence the distribution means for each category, in each location, are similar. There is no evidence to indicate a difference in rank category sample means for each of the treatments. Based upon the results of this test, the individual rank category means shown at Appendix B were used in the simulation to assign a rank to each entity.

Table VIII

Passenger Rank Category Probability Distributions

LOCATION	CATEGORY (per cent) 1	2	3	4	5
Richmond	0.313	0.147	0.323	0.143	0.074
Williamtown	0.290	0.143	0.364	0.112	0.091
Amberley	0.334	0.147	0.350	0.106	0.063
Townsville	0.352	0.148	0.345	0.098	0.066
Darwin	0.348	0.145	0.373	0.102	0.032
Pearce	0.350	0.138	0.337	0.124	0.042
Edinburgh	0.273	0.147	0.323	0.143	0.114
Laverton	0.300	0.143	0.361	0.113	0.082
Fairbairn	0.262	0.148	0.335	0.145	0.110

Official Business Data. Official business data as described in Chapter III was collected and the following results were extracted. The bar graph at Figure 2 shows the frequency distribution for the day personnel were required at their TDY location. Most TDY activities appear to commence on a Monday or Tuesday and then taper off towards the end of the week. Figure 2 also shows the probability distribution for the day TDY tasks were completed. Most tasks are completed early in the week (Monday, Tuesday, or Wednesday). Task completion days were based upon the day of the week the member was able to return to his/her home location. The cumulative distributions for this data were used to perform inverse transformation functions on random numbers generated by the simulation model.

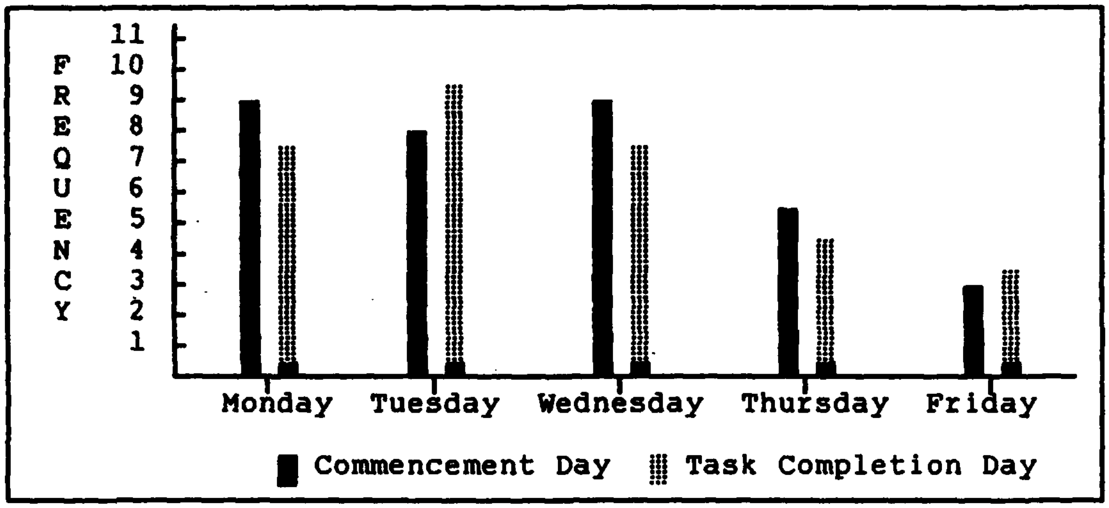


Figure 2. TDY Commencement Day and TDY Task Duration Frequency Distribution Bar Chart

<u>Salary Data</u>. Salaries used were for the direct cost per hour for each rank. Direct cost includes: salary (plus Service Allowance and Uniform Maintenance Allowance for Service personnel) and non-effective benefits such as superannuation, long service leave and leave bonus. Salary data was with effect 7 October 1987 (8:7A-1). Salary levels for each category were calculated by using the direct cost per hour for each rank grouped in the category and then dividing by the number of salary levels applicable to the category. For example, the various pay levels for a Corporal and below were added and then divided by the total number of salary levels applicable to the ranks. The full cost per hour, calculated by Defence Costing Branch, was not used as this cost includes the provision of utilities which, although costed across the entire defence workforce, may not be

applicable to all individuals. For example, an airman working in a maintenance hanger may not have a telephone sitting idle whilst he was TDY, or even an officer may share a telephone in an open work place. Also lighting and heating need to be made available for the benefit of others. Table IX lists the salary levels used for each of the five categories.

Table IX

<u>Personnel Cost Rates Used for Each Category</u>

CATEGORY	PERSONNEL COST RATE/HOUR
1	$16.12
2	$19.41
3	$20.91
4	$27.54
5	$32.18

Source: (8:7A-1)

<u>Travel Transit Time Data</u>. The number of productive hours lost travelling by RAAF scheduled air services and commercial flights was calculated using the RAAF Scheduled Service Timetable and the Australian Airline Flight schedule. Travel between the hours of 0830 and 1630 was considered productive time lost. Travel times are calculated based upon the assumption that a seat is available on the flight required. Commercial travel outside the working hours was assumed to be utilised if flights were scheduled and met the travellers

requirements. For example, if a traveller wanted to travel from Melbourne to Canberra and a commercial flight was leaving at 1700 hours, then this flight would be taken and no productive time would be lost. Travel time used in the study included the check-in time prior to departure that both military and commercial terminal operators set. A RAAF report time of one hour before departure and a commercial report time of thirty minutes prior to departure were used in the study. A sample of the travel time data base used in the simulation is at Appendix C.

Simulation Outline

Estimation of the opportunity cost of lost productive time was made using a SLAM II simulation program and network. The simulation network diagram at Appendix D was used to develop the simulation program. Appendix E is the translation of the network diagram into SLAM II code. Two userwritten subroutines were used to simplify the model and to incorporate real world aspects into the model. The userwritten subroutines enabled the input of the data files (travel time and salary) to the SLAM execution file. A copy of these subroutines is included at Appendix F.

Variables within the model are set by assignment of values to the attribute variables of an entity when it transits through the model (16:120). Variables include;

1. start day (the day required at the TDY location),

2. return day (the day return travel can be undertaken),

3. rank (the random allocation of a rank to the entity),

4. origin (the location from which the traveller is departing),

5. policy (the maximum time allowed to be in transit in either direction before commercial air is considered), and

6. destination (the location to which travel is required).

Variables for the origin, destination , and policy are set by the user, the remainder are assigned by the model and are based upon cumulative distribution functions developed from the data.

Statistics are collected from the simulation through the use of applicable SLAM II network input statements. The statistics to be collected are identified in the SLAM II network program by SLAM II control statements.

Verification and Validation of the Model. The model was verified by including tracing statements in the userwritten code. These statements allowed the tracing of values through the model. The trace was printed into the output file where it could be referenced for verification of the model. Verification of the SLAM II network was made possible by the use of a monitor trace statement during the building of the model. This trace simply followed an entity through the model and enabled confirmation of the assignment of suitable values to the network assigned attributes.

The model was validated simply on face value. No real data was available for comparison to the simulation output. However, from personal experience with the system being modelled, the results appear to be reasonable. Results obtained were shown to other Australian service personnel who agreed that the results were valid and acceptable.

Model Design. The simulation model was designed to create five samples of 1000 entities each. Each simulation run provided the average opportunity cost for travelling between the two locations nominated. The results of the five simulation runs were then averaged by hand to give a 'grand mean' for the opportunity cost of travelling the movement route nominated. Five simulation runs were made so as to use a different random number seed each time, thus providing a more realistic sample. The simulation program was used first to calculate the opportunity cost of the average time lost on each travel route by military scheduled air services and commercial flights. The opportunity cost calculated was the average cost which would be incurred for a particular travel route if everyone was required to travel by that mode. The results of this simulation run are shown in Table X.

Next the simulation model was run with the current RAAF personnel movement policy incorporated. If travel time exceeded more than three working days (Policy = 24 hours) then commercial air was to be considered. Travel requirements that met this criteria were assumed to be flown by commercial air. The results of the simulation,

Table X

<u>OPPORTUNITY COST OF TRAVEL TIME</u>

TRAVEL ROUTE	MILITARY *(1)	COMMERCIAL *(2)	CURRENT POLICY *(3)
RIC - WLM	311.00	0.00 *(4)	162.00
RIC - AMB	149.20	0.00	149.20
RIC - TVL	312.00	63.80	291.70
RIC - DAR	506.00	137.00	420.00
RIC - PEA	506.00	79.80	320.50
RIC - EDN	338.00	0.00	206.00
RIC - LAV	107.00	21.00	131.10
RIC - FBN	70.80	0.00	71.20
WLM - AMB	226.00	101.20	326.70
WLM - TVL	306.00	63.80	329.70
WLM - DAR	506.00	137.00	420.00
WLM - PEA	506.00	47.90	291.40
WLM - EDN	370.00	0.00	223.00
WLM - LAV	168.00	40.70	211.80
WLM - FBN	100.00	47.70	144.80
WLM - RIC	346.00	0.00	175.00
AMB - TVL	289.80	47.70	340.80
AMB - DAR	662.00	168.00	506.00
AMB - PEA	831.60	79.80	79.80
AMB - EDN	721.00	79.80	79.80
AMB - LAV	222.50	62.40	284.90
AMB - FBN	259.40	64.16	278.30
AMB - RIC	155.20	0.00	155.20
AMB - WLM	289.20	63.30	313.20
TVL - DAR	695.00	161.00	582.00
TVL - PEA	841.00	128.00	128.00
TVL - EDN	511.00	102.00	375.60
TVL - LAV	458.00	128.00	488.00
TVL - FBN	312.00	63.80	336.70
TVL - RIC	301.00	0.00	252.00
TVL - WLM	301.00	137.00	409.00
TVL - AMB	301.00	0.00	252.00
DAR - PEA	1180.00	22.50	22.50
DAR - EDN	836.00	63.80	241.20
DAR - LAV	569.00	79.80	414.00
DAR - FBN	504.00	128.00	352.00
DAR - RIC	496.00	63.80	292.50
DAR - WLM	503.00	128.00	352.00
DAR - AMB	706.00	82.90	82.90
DAR - TVL	691.00	161.00	579.00

Table X (cont'd)

OPPORTUNITY COST OF TRAVEL TIME

TRAVEL ROUTE	MILITARY *(1)	COMMERCIAL *(2)	CURRENT POLICY *(3)
PEA - EDN	425.00	68.30	320.60
PEA - LAV	504.00	63.80	300.60
PEA - FBN	504.00	85.00	334.50
PEA - RIC	504.00	137.00	409.00
PEA - WLM	504.00	137.00	416.00
PEA - AMB	842.60	101.20	101.20
PEA - TVL	839.00	137.00	137.00
PEA - DAR	1170.00	98.50	98.50
EDN - LAV	156.00	21.00	175.60
EDN - FBN	204.00	63.80	262.40
EDN - RIC	179.00	0.00	177.00
EDN - WLM	204.00	63.80	262.40
EDN - AMB	674.00	0.00	333.00
EDN - TVL	525.00	31.90	348.00
EDN - DAR	539.00	68.30	338.40
EDN - PEA	419.00	31.90	276.20
LAV - FBN	67.50	0.00	69.30
LAV - RIC	80.70	21.00	103.00
LAV - WLM	92.50	68.30	159.60
LAV - AMB	197.00	45.40	242.40
LAV - TVL	301.00	68.30	330.30
LAV - DAR	395.00	90.60	364.30
LAV - PEA	506.00	0.00	257.00
LAV - EDN	307.00	21.00	256.10
FBN - RIC	71.10	0.00	71.00
FBN - WLM	67.50	0.00	69.30
FBN - AMB	217.80	0.00	219.00
FBN - TVL	285.00	68.30	321.10
FBN - DAR	370.00	85.40	330.70
FBN - PEA	506.00	0.00	257.00
FBN - EDN	363.00	0.00	214.00
FBN - LAV	120.00	0.00	120.00

Notes:

(1) The average cost of time spent travelling on a route if all personnel were to travel military air.

(2) The average cost of time spent travelling on a route if all personnel were to travel commercial air.

(3) The average cost of time spent travelling on a route under the present personnel movement policy.

(4) An opportunity cost of zero shows travel is always outside of productive working hours.

incorporating the policy guideline, are also contained in Table X. Comparison of the simulation run which incorporated the current RAAF policy, and the first simulation runs whereby everyone travelled by the one mode shows that the policy reduces the opportunity cost of travel by military air by more than 50 per cent in most cases. Commercial air figures remain relatively the same; despite the decrease in the number of personnel who travel military air as a result of the policy requirement.

<u>Description of Simulation Output</u>. Table X provides output based upon three different RAAF personnel movement policies. First, the opportunity cost shown under the heading 'Military' is the opportunity cost that would be incurred by each individual, if personnel were required to travel by military air (RAAF scheduled services) only. This cost was obtained by setting the policy variable of the simulation to a value greater than 40.0; such a value is in excess of the number of productive hours that constitute the cyclical nature of the RAAF scheduled services (5 days X 8 hours per day = 40 hours per cycle). The result of this policy setting is that everyone will wait for the next RAAF scheduled air service for movement. The simulation model was designed such that if the travel time was greater than the policy variable, then commercial air was used. The opportunity cost figure accounts for persons who have not had to wait for the service and those that have had to wait up to five days. The opportunity cost is the average cost given

this variability in waiting time. Next, the opportunity cost shown under the 'Commercial' column of Table X is the cost if personnel were to use commercial air only. Waiting time in this case is zero, and personnel take the first available commercial flight.

Lastly, the opportunity cost of current RAAF policy is shown in Table X as 'Current Policy'. For example, over the travel route DAR to LAV a service member can wait up to three days in order to travel on a RAAF scheduled service. The opportunity cost of this 'waiting' can vary between zero dollars and A$579.00. However, another person may go commercial air almost immediately due to the next scheduled military service being four days away. The opportunity cost when this occurs can vary between zero dollars and A$161.00. The opportunity cost calculated by the simulation accounts for this variability and provides a total average cost per individual traveller over a particular travel route. Total estimated costs of travel over each route, used to test Hypothesis III, have been calculated by the simulation using the same principles as described above.

Comparison of Military and Commercial Opportunity Costs

The estimated opportunity costs of travel by military scheduled air services and commercial flight, under the present RAAF policy for the movement of personnel, were compared using the Wilcoxon Signed Rank Test for the Paired

Difference Experiment. This non-parametric statistical test was chosen for the following reasons:

1. A random sample of pairs of observations was taken.

2. The absolute differences in the paired observations could be ranked.

3. No assumptions had to be made about the form of the population probability distributions.

Non-parametric tests are used for comparing the probability distributions of random and independent samples. If one can infer that the distribution of one lies above (to the right of) the other, the implication is that the product being tested is more preferred or more expensive (15:736). For the purpose of this study, if the distribution of either the military costs or commercial costs lies to the right of the other then it can be inferred that the cost associated with that product is more expensive and therefore not as cost-effective as the other.

Hypothesis I was tested using the following non-parametric hypotheses:

H_0: The probability distribution corresponding to the opportunity cost of travelling on a commercial air service and the opportunity cost of travelling on a military scheduled air service, for equivalent travel requirements, are identical.

H_a: The probability distribution corresponding to the opportunity cost of travelling on a military scheduled air service lies above (to the right of) that for the opportunity cost of travelling on an equivalent commercial air service.

As the number of observations for the sample exceeded 25, the reject region for the null hypothesis was $Z > Z_\alpha$. The level of significance chosen for the test was 99.9 per cent ($\alpha = 0.001$). The null hypothesis could be rejected if the test statistic calculated exceeded $Z_\alpha > 3.09$ (15:964). The Z test statistic was then calculated and found to be 6.955. The conclusion was then reached that the null hypothesis could be rejected with a 99.9 per cent level of confidence. The probability distribution for the opportunity cost of travelling on RAAF scheduled air services lies to the right of the probability distribution for commercial air opportunity costs of travel. The inference that is drawn from this conclusion is that in terms of the opportunity cost of time spent travelling, commercial air was more cost-effective than travelling via RAAF scheduled air services.

Hypothesis II

Hypothesis II sought to determine the cost-effectiveness of RAAF scheduled air services with respect to the financial cost of operating these air services. The hypothesis tested was that when the provision of RAAF scheduled air services is

costed, current RAAF policy for the movement of personnel is not cost-effective if compared to equivalent commercial air travel.

Analysis

Analysis of this hypothesis was performed in three parts. First, the 'cost' of a seat on a RAAF scheduled air service was determined. This cost, or passenger tariff rate, was then used to calculate a RAAF airfare for travel between major RAAF bases. Next the commercial travel cost for the equivalent journey by commercial air was calculated. Finally, the two costs were compared and inferences about the differences between the two costs were made.

Calculation of Travel Cost by RAAF Scheduled Air Service. The ASIF costing methodology was used to cost the passenger tariff rate for RAAF scheduled air services. The computation of the tariff is a straightforward mathematical calculation: budgeted expenses chargeable divided by the forecasted workload equals the tariff rate. Budgeted expenses chargeable to the operation of ASIF flights were listed previously in Table VI. The percentage figure shown beside each of these expenses represents that portion of the total cost that is incurred as a direct result of the ASIF operations. The reason for the ASIF being allocated this cost is that MAC utilises these flights for training purposes; they are not flights additional to the training requirements of MAC. The operation of RAAF scheduled air services is not considered

essential to the operating squadrons training requirements (3). Therefore, the costs incurred in operating such a schedule of air services is fully attributable as a cost of providing the service to the ADF. The cost of providing RAAF scheduled air services can be based upon a 100% allocation of operating costs per hour. RAAF costing elements, equivalent to those used by the ASIF, which were included in the calculation of the total operating cost per hour for RAAF scheduled air services are:

1. Petrol, Oils, and Lubricants (POL) - this element is calculated by multiplying the aircraft consumption rate per hour by the average purchase price.

2. Spares Usage - this cost is based upon the grand mean of average funds obligated for C130 Hercules spares over the past five financial years divided by the total number of hours to be flown in the financial year for which costs are being estimated.

3. Contract Servicing - expenditure on servicing tasks performed by civilian contractors, for each aircraft type, is calculated by dividing the mean cost for the past five years by the total number of hours to be flown by the aircraft type in the year ahead.

4. Aircraft Servicing - the cost of man-hours required to maintain the aircraft is obtained from the RAAF Annual Maintenance Program which is calculated on the basis of the annual flying rate for the aircraft type.

5. Capital Costs - the amount of depreciation on an airframe per hour is calculated by taking the depreciation rate of the historical value of the aircraft over the forecasted life of type of the aircraft.

6. Departmental Oncosts - the cost of managing C130 Hercules operations divided by the total number of flying hours (23).

Appropriate cost figures were obtained for each of these elements from the Defence Costing Branch, Canberra. Table XI provides details of the estimated operating costs per hour for RAAF C130 Hercules operations. The RAAF operates both E and H model C130 Hercules and the cost for some of the above cost elements is different, depending on which model is examined. Therefore, for the purpose of this study, the cost per element has been averaged. The number of scheduled air services provided by each aircraft model is assumed to be equal over time.

Flying hours allocated to scheduled air service operations, flown by C130 Hercules aircraft in FY 87/88, are 1890 hours. Total scheduled air service operating costs for FY 87/88 were estimated by multiplying allocated flying hours by the estimated cost per hour of operation. The result is a total annual cost of A$7,113,015 being attributable to scheduled air services flown by C130 Hercules aircraft in FY 87/88. However, scheduled air services are also utilised for special cargo airlift. In order to accommodate this

Table XI

C130 Hercules Operating Costs per Hour
(all costs are $A)

Cost Element	Cost per Hour
POL	$849.00
Spares	$624.00
Contract Services	$472.00
Aircraft Services	$623.00
Capital Cost	$508.00
Departmental Oncost	$687.50
Estimated Total Cost	$3763.50

Source: (8:7B-1)

requirement, an allocation of 400 hours annually will be assumed necessary. These hours would be utilised by unscheduled air services which are operated for the primary purpose of cargo movement, but would also be available for use by space available duty and opportunity passengers. Therefore, for the purpose of this study, the estimated total annual cost of scheduled air service operations, flown by C130 Hercules aircraft, for FY 87/88 was estimated to be A$5,457,075 (1490 hours X A$3763.50 per hour).

Under ASIF operating procedures, the total annual cost figure is the amount which is to be recovered from the airlift users. This is accomplished by applying passenger and cargo tariffs to the provision of the airlift service. The passenger tariff rate per mile is calculated using the following data:

1. Estimates, provided by major commands, of passenger numbers over the various travel routes for the next financial year; and

2. The estimated total annual cost of providing the airlift service.

The passenger tariff rate is determined by dividing the estimated total annual operating cost by the estimated number of passenger miles to be flown. Using the ASIF method of determining the tariff rate, the RAAF passenger tariff rate is calculated as A$0.1723 per passenger mile. Appendix G shows the estimation of RAAF annual passenger miles which was used to determine the RAAF passenger tariff rate.

The cost of travel on a RAAF scheduled air service is then determined by taking the air distance between the origin and destination and multiplying by the passenger tariff rate. The air distance used is the most direct route between origin and destination, and not the distance over the route flown by the RAAF scheduled air service. Under ASIF, passengers are not charged for the actual miles flown as aircraft routing is beyond their control. However, should a passenger choose to break the journey at some location enroute, then the cost charged is the summation of the individual sectors flown. RAAF 'airfares' calculated for the travel between the various RAAF bases by scheduled air services are shown in Table XIV. Ground transport costs have been included for RAAF estimates when transiting through RAAF Laverton, as the majority of

the TDY travel to the Melbourne region is for activities at Headquarters Support Command.

Calculation of Commercial Air Travel Cost. Commercial air travel cost includes both airfare and ground transportation costs. Airfares used in the study are the one way economy fare for commercial flights between the primary commercial airfields located closest to the RAAF bases. Table XII provides details of the commercial airfares used in this study. Ground transport costs were calculated by taking the distance between the RAAF base and the commercial airfield and multiplying by the current motor vehicle rate (as determined by Defence Costing Branch). The vehicle type used for ground transportation costing in the study was a small bus; the rate per kilometre (excluding driver) is A$0.21 (8:7D-1). Table XIV also shows the commercial travel costs for each of the travel sectors. Table XIII shows the ground transport costs and distances used in the study.

Table XII

COMMERCIAL AIRFARES - One Way Economy
(all costs are in $A)

From	To RIC	WLM	AMB	TVL	DAR	PEA	EDN	LAV	FBN
RIC	-	55	176	297	453	444	234	171	95
WLM	55	-	231	352	508	499	289	226	150
AMB	176	231	-	227	410	470	289	261	206
TVL	297	352	227	-	338	456	322	377	322
DAR	453	508	410	338	-	411	388	453	472
PEA	444	499	470	456	411	-	342	396	428
EDN	234	289	289	322	388	342	-	161	208
LAV	171	226	261	377	453	396	161	-	134
FBN	95	150	206	322	472	428	208	134	-

Source: AA Fares (Effective 23Jul87)

Table XIII

GROUND TRANSPORT COSTS
(all costs are in A$)
(distance in kilometres)

Trip	Distance	Cost
AMB - BNE	70 kms	14.70
RIC - SYD	70 kms	14.70
LAV - TLM	20 kms	4.20
EDN - ADL	50 kms	10.50
PEA - PTH	60 kms	12.60

Table XIV

MILITARY AND COMMERCIAL AIRFARE CHARGES
(all costs are in A$)

Flight Sector	Military Cost	Commercial Cost
RIC - WLM	12.40	69.70 *
RIC - AMB	64.90	205.40 *
RIC - TVL	152.83	311.70 *
RIC - DAR	289.46	467.70 *
RIC - PEA	305.66	471.20 *
RIC - EDN	55.82	259.20 *
RIC - LAV	69.60	187.90 *
RIC - FBN	22.57	109.70 *
WLM - AMB	53.93	245.70 *
WLM - TVL	147.14	352.00
WLM - DAR	291.88	508.00
WLM - PEA	314.62	511.60 *
WLM - EDN	115.96	299.50 *
WLM - LAV	79.60	230.20 *
WLM - FBN	34.97	150.00
AMB - TVL	103.55	241.70 *
AMB - DAR	264.65	424.70 *
AMB - PEA	333.57	497.20 *
AMB - EDN	144.73	314.20 *
AMB - LAV	126.64	279.90 *
AMB - FBN	53.92	220.70 *
TVL - DAR	174.02	338.00
TVL - PEA	314.96	468.60 *
TVL - EDN	176.60	332.50 *
TVL - LAV	192.96	381.20 *
TVL - FBN	175.40	322.00
DAR - PEA	244.66	423.60 *
DAR - EDN	241.74	398.50 *
DAR - LAV	293.08	457.20 *
DAR - FBN	290.10	472.00
PEA - EDN	199.00	365.10 *
PEA - LAV	253.11	412.80 *
PEA - FBN	289.12	440.60 *
EDN - LAV	61.17	175.70 *
EDN - FBN	90.11	218.50 *
LAV - FBN	45.49	138.20 *

Note: Ground transport costs have been added to those sectors where * is shown.

Comparison of Military and Commercial Costs. The costs of travel by military air and commercial air were compared using the Wilcoxon Signed Rank Test for the Paired Difference Experiment. The non-parametric hypotheses used in the Wilcoxon Signed Rank Test were:

H_0: The probability distribution corresponding to the estimated RAAF airfare for travel via RAAF scheduled air services, between the nine primary RAAF locations, and the cost of travelling via an equivalent commercial flight, are identical.

H_a: The probability distribution for the cost of travelling on a commercial flight lies above (to the right of) the probability distribution for the estimated RAAF airfare for the equivalent travel requirement.

The results show that the null hypothesis could be rejected at the 99.9% level of significance. The test statistic calculated for the test was 5.2316. The conclusion that can be made from this test is that the probability distribution for the cost of travel on commercial flights is to the right of the probability distribution for estimated travel airfares on equivalent RAAF scheduled air services. The inference made from this hypothesis test is that commercial costs are significantly higher than the military costs.

When the estimated airfares for travel by RAAF scheduled air service, between primary RAAF locations, are compared to

the commercial travel costs for equivalent journeys, the results of the analysis indicate that travel via RAAF scheduled air service is cost-effective.

Hypothesis III

The cost of moving RAAF personnel on TDY tasks is made up of two major components. Firstly, the cost of airfares, or in the case of RAAF scheduled air service flights, the cost of providing the service. The second major cost, although often dismissed, is the opportunity cost of productive time lost when travelling on TDY tasks. Each of these two costs have been calculated for travel by RAAF scheduled air services and commercial air and tested individually in Hypothesis II and I respectively.

In order to test Hypothesis III, that the cost of moving personnel in accordance with current RAAF policy is cost-effective, these two costs have been combined for each method of travel. The Wilcoxon Signed Rank Test for Paired Difference experiments was again used to test for any difference in the probability distributions of the total costs for each method of travel. Table XV details the total costs estimated for each method of travel for each travel route combination.

Table XV

ESTIMATED TOTAL COSTS OF TRAVEL

TRAVEL ROUTE	POLICY *(1)	COMMERCIAL *(2)
RIC - WLM	642.00	69.40
RIC - AMB	216.00	205.40
RIC - TVL	518.00	387.40
RIC - DAR	917.00	630.70
RIC - PEA	780.00	539.70
RIC - EDN	591.00	259.20
RIC - LAV	402.00	209.00
RIC - FBN	362.00	109.70
WLM - AMB	279.00	345.40
WLM - TVL	511.00	427.70
WLM - DAR	952.00	671.00
WLM - PEA	764.00	552.00
WLM - EDN	363.00	229.50
WLM - LAV	461.00	274.00
WLM - FBN	392.00	193.80
WLM - RIC	684.00	69.70
AMB - TVL	400.00	285.50
AMB - DAR	1060.00	593.70
AMB - PEA	551.00	377.00
AMB - EDN	851.00	394.00
AMB - LAV	354.00	342.30
AMB - FBN	313.00	297.00
AMB - RIC	215.00	205.40
AMB - WLM	352.00	320.90
TVL - DAR	989.00	499.00
TVL - PEA	600.00	596.60
TVL - EDN	570.00	422.10
TVL - LAV	689.00	535.20
TVL - FBN	372.00	397.70
TVL - RIC	499.00	311.70
TVL - WLM	535.00	509.00
TVL - AMB	405.00	241.70
DAR - PEA	433.00	446.10
DAR - EDN	851.00	461.70
DAR - LAV	928.00	522.20
DAR - FBN	860.00	575.00
DAR - RIC	805.00	518.20
DAR - WLM	881.00	611.00
DAR - AMB	495.00	507.60
DAR - TVL	981.00	494.00

Table XV (cont'd)

ESTIMATED TOTAL COSTS OF TRAVEL

TRAVEL ROUTE	POLICY *(1)	COMMERCIAL *(2)
PEA - EDN	837.00	440.70
PEA - LAV	825.00	464.40
PEA - FBN	853.00	526.10
PEA - RIC	858.00	631.20
PEA - WLM	858.00	671.60
PEA - AMB	572.00	598.40
PEA - TVL	606.00	605.60
PEA - DAR	509.00	522.10
EDN - LAV	283.00	196.30
EDN - FBN	258.00	276.90
EDN - RIC	420.00	259.20
EDN - WLM	258.00	357.90
EDN - AMB	780.00	314.20
EDN - TVL	627.00	362.50
EDN - DAR	780.00	479.90
EDN - PEA	767.00	385.30
LAV - FBN	194.00	138.20
LAV - RIC	374.00	208.90
LAV - WLM	386.00	295.90
LAV - AMB	326.00	325.30
LAV - TVL	453.00	459.50
LAV - DAR	785.00	550.50
LAV - PEA	820.00	512.80
LAV - EDN	412.00	196.80
FBN - RIC	359.00	109.70
FBN - WLM	358.00	150.00
FBN - AMB	273.00	220.70
FBN - TVL	342.00	400.10
FBN - DAR	753.00	571.70
FBN - PEA	829.00	440.60
FBN - EDN	344.00	218.50
FBN - LAV	247.00	138.20

Notes:

(1) Average cost per person to travel sector, when three day movement policy is used. A mix of military and commercial flights are used.

(2) Average cost per person to travel sector when everyone travels by commercial air.

The hypotheses used to test for identical probability distributions were:

H_o: The probability distributions corresponding to the total estimated cost of using RAAF scheduled air services and the total estimated cost for travelling the equivalent journey on a commercial flight are identical.

H_a: The probability distribution corresponding to the total estimated cost of using RAAF scheduled air services lies above (to the right of) the probability distribution for the total estimated cost for travelling the equivalent journey by commercial air services.

The level of confidence used in the hypothesis test was again 99.9 per cent. Therefore, to be able to reject the null hypothesis the Z test statistic had to be greater than $Z_\alpha = 3.09$. The test statistic was found to be 6.592 and the conclusion was made that the null hypothesis could be rejected. This conclusion infers that the probability distribution for the cost of TDY travel under current RAAF personnel movement policy conditions lies above the probability distribution of costs for equivalent journeys on commercial air services.

Sensitivity Analysis

A sensitivity analysis was conducted to determine at what policy level, if any, travel by RAAF scheduled air services became as cost-effective as travel by commercial air. The simulation model was rerun for each of the travel routes using a policy of one day, in lieu of the current three day policy. The one day policy requires service personnel to wait no longer than one working day before consideration is given to travelling commercial air. The cost of travelling the routes was again compared to equivalent commercial routes using the Wilcoxon Ranked Sum Test for the Paired Difference Experiment. The results showed that at the 99.9% level of confidence the probability distributions for the cost of travelling on a commercial flight and the cost of travelling in accordance with the one day policy were identical. The test statistic calculated for this test was 1.8793. An interesting outcome of this policy was that travel to and from RAAF bases such as DAR, TVL, and PEA was undertaken entirely by commercial air.

Conclusions

Three research hypotheses were tested to determine if present RAAF policy for the movement of personnel on TDY was cost-effective when compared to a policy of travel by commercial air only. The first hypothesis tested cost-effectiveness in terms of the opportunity cost of travel under the two policies. The result was that commercial air

is more cost-effective when compared on an opportunity cost basis. The next hypothesis tested compared commercial airfares to estimated RAAF airfares, over equivalent travel routes. Estimated RAAF airfares were calculated using a similar costing structure to the USAF Airlift Service Industrial Fund. The result of this hypothesis test was that the total cost of 'airfares' for travel on RAAF scheduled air services was more cost-effective than total commercial fares for equivalent routes. Finally, the total costs of travel under present RAAF policy and travel by commercial air only were compared. Total cost figures included opportunity cost and airfares. The final outcome was that current RAAF policy, for the movement of RAAF personnel, is not cost-effective when compared to the cost of travelling by commercial air only.

A sensitivity analysis was then conducted to determine if a change in RAAF policy would make travel by RAAF scheduled air services as cost-effective as travel by commercial air only. The effect of a change to a one day policy, was that travel under this policy was as cost-effective as travel by commercial air only.

V. Conclusions and Recommendations

Chapter Overview

The purpose of this final chapter is to draw conclusions from the findings of Chapter IV relevant to the research objective of determining whether or not current RAAF personnel movement policy is cost-effective. In addition this chapter provides recommendations for management action and further study.

Conclusions

The aim of this research study was to determine the cost-effectiveness of current RAAF policy for the movement of personnel on TDY tasks. This determination was made through the use of three research hypotheses.

TDY travel within the RAAF is undertaken through the use of RAAF scheduled air services. This mode of travel is considered a 'no-cost' means of moving personnel. Personnel travelling on TDY seldom travel by other modes of transport such as road, rail, or commercial air. Present RAAF policy requires that travel should be by the most economical means available, but service air if practicable. A policy guideline is that if more than three working days are lost in either the forward or return journey, then commercial air should be considered for that part of the trip. This research study compared this to a policy whereby everyone always travelled by commercial air.

In order to determine cost-effectiveness, the primary costs incurred when travelling were estimated. The two costs used in the study were;

1. the opportunity cost of lost productive time due to travel, and

2. the direct cost incurred when either military or commercial air was used.

Travel between each of the nine major RAAF bases located in Australia was used to determine overall cost-effectiveness. A total of 72 travel routes were compared.

Hypothesis I. The first hypothesis compared the opportunity costs incurred when travel, in accordance with each of the policies, over the 72 travel routes was undertaken. The results of this test show that the most cost-effective of the two policies is when everyone travels by commercial air only. This outcome can be attributed to the frequency of commercial flights (almost daily over all but a few of the routes), and the infrequency of the RAAF scheduled air services to many RAAF bases. The time spent travelling is further increased by the type of aircraft used for most RAAF scheduled air services, and the nature of the 'hub and spoke' operation at RAAF Richmond.

Hypothesis II. The second hypothesis compared the cost of commercial airfares (plus ground transfer costs where applicable) to the estimated RAAF passenger fare for each of the travel routes. RAAF passenger fares were estimated using the USAF ASIF costing structure. A passenger rate per mile

was calculated for RAAF scheduled air service operations and this was then used to estimate a cost for travel over each of the routes.

The conclusion drawn from this hypothesis test was that, based upon the cost of operating the RAAF scheduled air services and the number of personnel travelling via these services, current RAAF policy is cost-effective. The large difference found in the cost of the two policies can be partially attributed to the cost of salaries and administration. When costing the operation of RAAF scheduled air services, the cost of crew, maintenance staff, terminal operators, administration of booking services, and maintenance of facilities were not used. These facilities, personnel, and organisation (MOVCORDC) are a combat support requirement and are considered 'sunk' costs. That is, they are incurred regardless of the RAAF scheduled air services.

Hypothesis III. The third hypothesis compared the total cost cf each of the policies. The total cost includes the opportunity cost of lost productive time and the estimated cost of using the respective modes of travel. The results of this test show that the overall cost of travel is less for the policy where everyone travels by commercial air. Therefore, current RAAF policy for the movement of personnel

is not cost-effective. The cost with the most impact on this finding is the opportunity cost of productive time lost when service air is used.

A sensitivity analysis showed that if current policy was reduced from a maximum of three days waiting to a maximum of one day, then the two policies are equally as cost-effective. However, under a one day wait policy, RAAF bases such as PEA, TVL, and DAR incur delays that warrant travel by commercial air in most cases.

Recommendations

The findings of this research study show that the movement of RAAF personnel for TDY activities under the present RAAF policy is not cost-effective. The RAAF policy for the movement of personnel should be changed to allow the use of RAAF scheduled air services to be as cost-effective as possible. This occurs when the guideline for the use of RAAF scheduled air services is set at a limit of no more than one day. This policy reduces the amount of lost productive time, and the total cost of such a policy is equal to that incurred when everyone travels by commercial air.

The requirement to travel by service air if practicable should remain. However, RAAF managers should be provided sufficient flexibility in determining the best mode of travel for TDY purposes. Policy should provide for the RAAF manager to consider the parent unit's mission needs and the degree to which an individual's absence impacts these needs.

Development of a specific decision support system which enables the RAAF manager to evaluate and compare alternative modes of travel, other than military and commercial air, is essential. The RAAF manager may then choose the most cost-effective mode, or that mode which is most manpower efficient (i.e. the individual is TDY for the least amount of time).

A final recommendation is to investigate contracting the movement of personnel to a commercial airline. A personnel movements policy which enabled personnel to travel by commercial air at negotiated rates would be more cost-effective and also result in more efficient use of limited manpower resources. Deregulation of the Australian domestic airline industry in 1990 may further enhance the cost-effectiveness of TDY travel by commercial air. Overseas experiences with deregulation have seen significant reductions in the airfares as a result of a more competitive airline industry.

Further Research

There are two additional areas of research that are suggested by this study. The first involves the modelling of the RAAF airmovements infrastructure. Such a model would facilitate the development of an optimum RAAF Schedule of Air Services, and allow for movements staff to evaluate changes to RAAF policy, and changes in the level and distribution of

demand for these air services. The model could be designed to provide the most cost-effective schedule available while insuring the most efficient use of manpower resources.

The second area of study involves the development of the Specific Decision Support System (SDSS) outlined in the study's recommendations. The benefits from the development of this SDSS include the realisation of other modes of transport being available, and the added responsibility given to the RAAF manager regarding use of both his financial and human resources. The trade off decision between cost-effective travel and efficient use of manpower then becomes the responsibility of the manager who is aware of the constraints applicable to each individual decision regarding travel.

Appendix A: Joint Priorities for the Movement of Passengers and Cargo on Service Aircraft

AUSMIMPS Movement Priority (Cargo)	Passenger Equivalent	Time Limit for Transport to Destination
1.	a. AUSDIL passengers.	1 to 3 days
	b. Replacement of operational Crews.	
	c. Reinforcements.	
	d. Special moves authorised by DoD or Force Commanders.	
	e. Personnel proceeding on emergency/compassionate leave, or returning from same to an operational area.	
	f. AEROMEDEVAC teams and patients classified as urgent or priority.	
2.	a. Ferry crews.	4 to 8 days
	b. Duty personnel on staff visit/posting /attachment.	
	c. Personnel proceeding on emergency/compassionate leave.	
	d. Civilians from Government departments on urgent Defence business.	

AUSMIMPS Movement Priority (Cargo)	Passenger Equivalent	Time Limit for Transport to Destination
3.	a. Administrative troop/ personnel movements.	9 to 15 days
	b. Personnel returning to unit after escort duty.	
	c. Civilians from industry, Government departments or semi-government organisations on defence business.	
	d. Personnel proceeding on emergency/compassionate leave.	
	e. AEROMEDEVAC patients classified as Routine.	
4.	a. Personnel on leave travelling at public expense, or returning to a non-operational area after emergency/ compassionate leave.	16 to 20 days
5.	Non-priority passengers:	
	a. Compassionate/emergency leave not otherwise specified.	21 days or over
	b. Space available passengers.	
	c. Civilians travelling on Government business.	
	d. Dependents of members travelling at public expense.	

Appendix B : Comparison of Rank Structures from Each RAAF Location

SAS

ANALYSIS OF VARIANCE PROCEDURE

CLASS LEVEL INFORMATION

CLASS	LEVELS	VALUES
TREAT	5	cpl flt sgt sldr wcdr
GROUP	9	amb dar edn fbn lav pea ric tvl wlm

NUMBER OF OBSERVATIONS IN DATA SET = 45

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: X

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	12	0.53168956	0.04430746	67.24
ERROR	32	0.02108742	0.00065898	PR > F
CORRECTED TOTAL	44	0.55277698		0.0001

R-SQUARE	C.V.	ROOT MSE	X MEAN
0.961852	12.8367	0.02567064	0.19997778

SOURCE	DF	ANOVA SS	F VALUE	PR > F
TREAT	4	0.53165698	201.70	0.0001
GROUP	8	0.00003258	0.01	1.0000

SAS

ANALYSIS OF VARIANCE PROCEDURE

TUKEY'S STUDENTIZED RANGE (HSD) TEST FOR VARIABLE: X
NOTE: THIS TEST CONTROLS THE TYPE I EXPERIMENTWISE ERROR RATE,
BUT GENERALLY HAS A HIGHER TYPE II ERROR RATE THAN REGWQ

ALPHA=0.05 DF=32 MSE=6.6E-04
CRITICAL VALUE OF STUDENTIZED RANGE=4.086
MINIMUM SIGNIFICANT DIFFERENCE=.03497

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

TUKEY GROUPING	MEAN	N	TREAT
A	0.34567	9	flt
A			
A	0.31356	9	cpl
B	0.14511	9	sgt
B			
B	0.12067	9	sldr
C	0.07489	9	wcdr

Appendix C : Sample of Travel Time Data

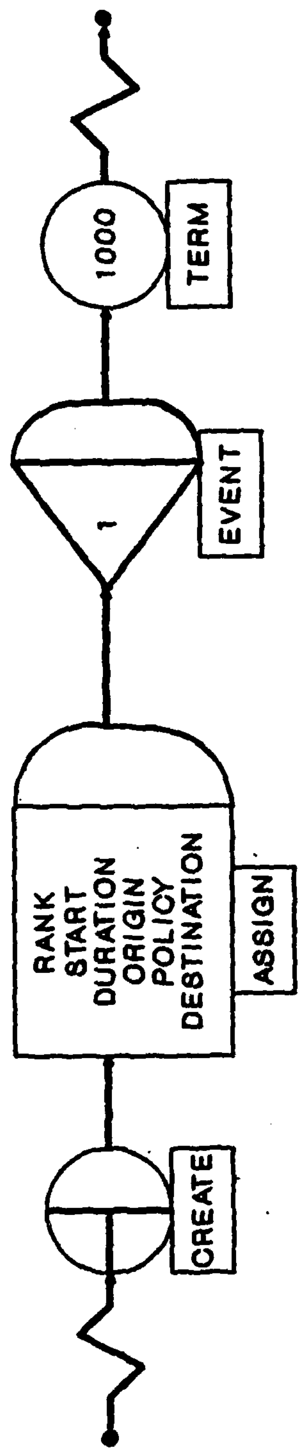
Darwin to Laverton - Travel Time Data
(all times are in hours)

Conference Start (ISTART)	Conference Duration (IDURN)	Military Forward (RMF)	Military Return (RMR)	Commercial Forward (CF)	Commercial Return (CR)
Monday	1	35	11	0	5
	2	35	32	0	5
	3	35	24	0	5
	4	35	16	0	5
	5	35	11	0	5
Tuesday	1	40	32	5	5
	2	40	24	5	5
	3	40	16	5	5
	4	40	11	5	5
	5	40	11	5	5
Wednesday	1	18	24	5	5
	2	18	16	5	5
	3	18	11	5	5
	4	18	11	5	5
	5	18	32	5	5
Thursday	1	16	16	5	5
	2	16	11	5	5
	3	16	11	5	5
	4	16	32	5	5
	5	16	24	5	5
Friday	1	27	11	5	5
	2	27	11	5	5
	3	27	32	5	5
	4	27	24	5	5
	5	27	16	5	5

Richmond to Laverton - Travel Time Data
(all times are in hours)

Conference Start (ISTART)	Conference Duration (IDURN)	Military Forward (RMF)	Military Return (RMR)	Commercial Forward (CF)	Commercial Return (CR)
Monday	1	3	3	1	1
	2	3	2	1	1
	3	3	3	1	1
	4	3	8	1	1
	5	3	3	1	1
Tuesday	1	8	2	1	1
	2	8	3	1	1
	3	8	8	1	1
	4	8	3	1	1
	5	8	3	1	1
Wednesday	1	3	3	1	1
	2	3	8	1	1
	3	3	3	1	1
	4	3	3	1	1
	5	3	2	1	1
Thursday	1	8	8	1	1
	2	8	3	1	1
	3	8	3	1	1
	4	8	2	1	1
	5	8	3	1	1
Friday	1	3	3	1	1
	2	3	3	1	1
	3	3	2	1	1
	4	3	3	1	1
	5	3	8	1	1

Appendix D : SLAM II Simulation Network Diagram



Appendix E : SLAM II Simulation Network Program

```
GEN,AGREEN,THESIS,21/4/88,5,,,,,Y/1,72;
LIMITS,1,6,250;

; This part of the program allows common terminology to be
; used by SLAM variables.

EQUIVALENCE/ATRIB(1),RANK/
            ATRIB(2),START/
            ATRIB(3),DURATION/
            ATRIB(4),ORIGIN/
            ATRIB(5),POLICY/
            ATRIB(6),DESTINATION;

;  The following STAT statements list the statistical
;  variables which are to be collected by the simulation.

STAT,1,COM COST FWD;
STAT,2,COM COST RTN;
STAT,3,MIL COST FWD;
STAT,4,MIL COST RTN;
STAT,5,COM FWD OP COST;
STAT,6,COM RTN OP COST;
STAT,7,MIL FWD OP COST;
STAT,8,MIL RTN OP COST;
STAT,9,TOTAL COST FWD;
STAT,10,TOTAL COST RTN;


;  The following arrays set up cumulative distribution
;  functions for the random generation of the following
;  variables:
;      Array (1)  Rank Structure Cumulative Distribution
;      Array (2)  Start Day Cumulative Distribution
;      Array (3)  Task Duration Cumulative Distribution
;      Array (4)  Variable value assigned to the attributes -
;                 represents the five classes within each
;                 category.

ARRAY(1,5)/0.3135,0.4586,0.8042,0.9248,1.00;
ARRAY(2,5)/0.228,0.428,0.656,0.856,1.00;
ARRAY(3,5)/0.257,0.599,0.799,0.939,1.00;
ARRAY(4,5)/1.0,2.0,3.0,4.0,5.0;
```

```
;  SLAM Network

NETWORK;

        CREATE,1,0;
        ASSIGN,RANK=DPROBN(1,4,1)/
               START=DPROBN(2,4,3)/
               DURATION=DPROBN(3,4,5);
        ASSIGN,ORIGIN=1.0/
               POLICY=24.0/
               DESTINATION=1.0;

        ACT;
        EVENT,1;
        ACT;
        TERM,1000;
        END;

SIMULATE;
SEEDS,0(1),0(2),0(3);
FIN;
```

Appendix F :   <u>SLAM II Userwritten Subroutines</u>

```
      SUBROUTINE EVENT (I)

C******
C     This event subroutine is based upon the travel times
C     assessed from both the military schedule and the
C     commercial schedule. Array TT is set up by reading an
C     external data file which contains the travel times
C     between the locations based upon the start and duration
C     times of the conference the entity has been assigned in
C     the SLAM II network.  These times are then compared to
C     the policy which has been set and the decision to
C     travel commercial or military is made.  Costs for the
C     forward and return journeys are calculated and the
C     statistics and values collected for output.
C******

      INCLUDE 'COMMON.FOR'
      INCLUDE 'UCOM.FOR'

C******
C     Initialise Fortran Variables.
C******

      RMF = 0.0
      RMR = 0.0
      RCF = 0.0
      RCR = 0.0
      MRCOS = 0.0
      MFCOS = 0.0
      CRCOS = 0.0
      CFCOS = 0.0

C******
C     Assign network attributes to Fortran variables.
C******

      IRANK = ATRIB(1)
      ISTART = ATRIB(2)
      IDURN = ATRIB(3)
      IORIGIN = ATRIB(4)
      IPOLICY = ATRIB(5)
      IDESTIN = ATRIB(6)



C******
```

```
C     If the IPOLICY variable has been set to zero in the
C     SLAM II network, then all entities travel commercial.
C******

      IF (IPOLICY.EQ.0) GO TO 2

C******
C     Time duration of military forward journey is obtained
C     from Array TT and compared to policy.  If less than
C     policy, military forward cost is calculated.
C******

1     RMF = TT(IORIGIN,ISTART,IDURN,IDESTIN,1)
      IF (RMF.GT.POLICY) THEN 130
      RMFCOS = (RMF*COST(IRANK))+MILFARE(IORIGIN,IDESTIN)
      RMFVAL = (RMF*COST(IRANK))
      GOTO 140

C******
C     If military forward time is greater than policy then
C     commercial cost is calculated and includes airfare
C     (one way economy).
C******

130   RMF = 0.0
      CF = TT(IORIGIN,ISTART,IDURN,IDESTIN,3)
      CFCOS = (CF*COST(IRANK))+COMFARE(IORIGIN,IDESTIN)
      CFVAL = CF*COST(IRANK)

C******
C     Military return time is obtained from Array TT and
C     compared to policy. If less than policy Return cost
C     vide military air is calculated.
C******

140   RMR = TT(IORIGIN,ISTART,IDURN,IDESTIN,2)
      IF (RMR.GT.POLICY) THEN 150
      RMRVAL = (RMR*COST(IRANK))
      RMRCOS = RMRVAL + MILFARE(IORIGIN,IDESTIN)
      GO TO 200

C******
C     Commercial return cost is calculated if miltary return
C     time is greater than policy.
C******

150   RMR = 0.0
      CR = TT(IORIGIN,ISTART,IDURN,IDESTIN,4)
      CRCOS = (CR*COST(IRANK))+AIRFARE(IORIGIN,IDESTIN)
      CRVAL = CR*COST(IRANK)
      GO TO 200

C******
```

```
C     Commercial costs are calculated for a policy whereby
C     everyone travels by commercial air only.
C******

2     CF = TT(IORIGIN,ISTART,IDURN,IDESTIN,3)
      CFCOS = (CF*COST(IRANK)) + COMFARE(IORIGIN,IDESTIN)
      CR = TT(IORIGIN.ISTART,IDURN,IDESTIN,4)
      CRCOS = (CR*COST(IRANK)) + COMFARE(IORIGIN,IDESTIN)
      CFVAL = CF*COST(IRANK)
      CRVAL = CR*COST(IRANK)

C******
C     Costs are summed and the values are stored for
C     statistical purposes.
C******

200   TOTCOSF = RMFCOS + CFCOS
      TOTCOSR = RMRCOS + CRCOS

      CALL COLCT(CFCOS,1)
      CALL COLCT(CRCOS,2)
      CALL COLCT(RMFCOS,3)
      CALL COLCT(RMRCOS,4)
      CALL COLCT(CFVAL,5)
      CALL COLCT(CRVAL,6)
      CALL COLCT(RMFVAL,7)
      CALL COLCT(RMRVAL,8)
      CALL COLCT(TOTCOSF,9)
      CALL COLCT(TOTCOSR,10)

      RETURN

      END
```

```
      SUBROUTINE INTLC

C******
C     This subroutine initialises the simulation program.
C     Four external files are read into the SLAM model to
C     create the Arrays TT, COST, COMFARE, and MILFARE. TT
C     contains the travel times to destinations for both
C     military and commercial modes of travel. COST contains
C     the average hourly salary for each of the five categories
C     assigned to the rank structure of the Australian
C     Defence Force.  COMFARE contains the one way economy
C     airfare plus ground transport costs for travel by
C     commercial air.  MILFARE contains the fares calculated
C     for travel on RAAF scheduled air services.
C******

      INCLUDE 'COMMON.FOR'
      INCLUDE 'UCOM.FOR'

C******
C     Read in file TTIME.DAT and form Array TT
C******

      OPEN(UNIT=1,FILE='TTIME',STATUS='OLD')
      DO 10 I=1,8
      DO 10 J=1,5
      DO 10 K=1,5
      DO 10 L=1,9

      READ(1,*)(TT(I,J,K,L,M),M=1,4)
10    CONTINUE
      CLOSE(1)

C******
C     Read in file COST.DAT and form Array COST
C******

      OPEN(UNIT=2,FILE='COST',STATUS='OLD')
      DO 20 I=1,5

      READ(2,*) COST(I)
20    CONTINUE
      CLOSE(2)
```

```
C******
C     Read in file COMFARE.DAT and form Array COMFARE
C******

      OPEN(UNIT=3,FILE='COMFARE',STATUS='OLD')
      DO 30 I=1,8

      READ(3,*)(COMFARE(I,J),J=1,9)
30    CONTINUE
      CLOSE(3)

C******
C     Read in file MILFARE.DAT and form Array MILFARE
C******

      OPEN(UNIT=4,FILE='MILFARE',STATUS='OLD')
      DO 40 I = 1,8

      READ(4,*)(MILFARE(I,J),J=1,9)
40    CONTINUE
      CLOSE(4)

      RETURN

      END
```

Appendix G : Calculation of Passenger Miles Flown Per Year on RAAF Scheduled Air Services

CALCULATION OF PASSENGER MILES FLOWN PER YEAR
ON RAAF SCHEDULED AIR SERVICES

Flight Sector (1)	Air Distance (Miles) (2)	Average # Passengers (3)	# Sectors Per Year (4)	Total Passengers/Year (5)	Passenger Miles/Sector (6)
RIC - WLM	72	4	50	200	14400
RIC - DAR	1680	23	50	1150	1932000
WLM - DAR	1694	4	50	200	338800
DAR - WLM	1694	3	50	150	254100
DAR - RIC	1680	26	50	1300	2184000
WLM - RIC	72	5	50	250	18000
RIC - AMB	372	31	100	3100	1153200
RIC - TVL	887	24	100	2400	2128800
AMB - TVL	601	22	100	2200	1322200
TVL - AMB	601	23	100	2300	1382300
TVL - RIC	887	29	100	2900	2572300
AMB - RIC	372	28	100	2800	1041600
RIC - EDN	614	7	150	1050	644700
RIC - PEA	1774	25	50	1250	2217500
EDN - PEA	1155	25	50	1250	1443750
PEA - EDN	1155	13	50	650	750750
PEA - RIC	1774	27	50	1350	2394900
EDN - LAV	355	12	150	1800	639000
EDN - RIC	614	5	150	750	460500
LAV - RIC	404	45	200	9000	3636000
RIC - FBN	131	12	150	1800	235800
RIC - LAV	404	28	150	4200	1696800
FBN - LAV	264	15	150	2250	594000
FBN - EDN	523	10	150	1500	784500
LAV - EDN	355	16	100	1600	568000
EDN - FBN	523	9	100	900	470700
LAV - FBN	264	17	150	2550	673200
FBN - RIC	131	6	150	900	117900
				TOTAL PAX MILES/Y	31669700

Notes:

1. Sectors shown are those over which the RAAF scheduled air services operate. The flight for direct flights over routes not shown are within are within 100 miles deviation of those routes flown by the scheduled air services.

2. Air distances have been taken from DI(AF)AAP 1127, Chapter 7, Annex A.

3. Average number of passengers on each sector has been calculated using Consolidation Lists provided by MOVCORDC.

4. The number of sectors per year is based upon the number of flights per week times 50 weeks of scheduled air service operations per year.

5. Total passengers per sector is the multiplication of the average number of passengers per sector by the number of sectors per year.

6. Total passenger miles per year is calculated by multiplying the sector air distance by the number of passengers per year travelling the sector.

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Abstract

The purpose of this research study was to determine the cost-effectiveness of current RAAF policy for the movement of personnel on temporary duty (TDY). TDY travel within the RAAF is undertaken through the use of RAAF scheduled air services. Personnel travelling on TDY seldom travel by other modes of transport such as road, rail, or commercial air. Present RAAF policy requires that travel be by the most economical means, but by service air if practicable. This study uses three research hypotheses to test the cost-effectiveness of this current policy when compared to a policy where everyone travels by commercial air when going TDY. Two costs are used to make this comparison; the opportunity cost of productive time lost when travelling, and the cost of providing the air service.

The methodology used to make the comparison consisted of a simulation model to estimate the opportunity cost of each policy and the total cost of each policy. The calculation of the cost of providing the military air services was made using the methodology the USAF apply to calculation of ASIF cargo and passenger rates.

The findings of the study show that the current RAAF policy for the movement of personnel on TDY is not cost-effective. The primary factor contributing to this outcome is the opportunity cost of productive time lost. The cost of providing the military air services are substantially less than equivalent commercial fares. The cost of personnel and administration, in the military, are necessary costs and have not been included in the cost of providing the military air services.

Recommended action to enable the movement of RAAF personnel on TDY to be cost-effective is to allow personnel to incur a loss of no more than one working day before consideration is given to travelling by other means.